

HANDBOOK OF  
X-RAY PHOTOELECTRON  
SPECTROSCOPY



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# Handbook of X-ray Photoelectron Spectroscopy

A Reference Book of Standard Spectra  
for Identification and Interpretation of XPS Data

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## Preface

X-ray Photoelectron Spectroscopy (XPS), also known as Electron Spectroscopy for Chemical Analysis (ESCA), is widely used to investigate the chemical composition of surfaces. The use of XPS in analytical laboratories throughout the world attests to the problem-solving capability of this technique. The ability to explore the first few atomic layers and assign chemical states to the detected atoms has shown XPS to be a powerful addition to any analytical laboratory.

A great deal of information has been published on the principles of the technique and the diverse range of applications for which it is used. Volumes of XPS spectra exist in the scientific literature, and international committees are establishing databases with reference spectra that will be made available to the general public. It is not the authors' intent to exclude these spectra or to ignore these databases. Rather the intent is to assemble a concise volume of standard spectra to aid in the identification of XPS data.

The previous version of this handbook, published in 1978, contained data acquired with a cylindrical mirror analyzer (CMA). Since that time, our XPS hardware has evolved. We currently use a spherical capacitance analyzer (SCA) in conjunction with improved detector technology and the choice of either a high-performance Al x-ray monochromator or an achromatic Mg/Al dual anode x-ray source. This handbook is an update of the previous handbook with data acquired using our current SCA, which has a transmission function different from that of a CMA, and both monochromatic and achromatic x-ray sources. In addition, data are included from several elements not contained in the previous handbook. This handbook is meant to serve as a guide and reference work for the identification, quantification, calibration and interpretation of XPS spectra for users of Perkin-Elmer XPS systems equipped with SCAs and Omni Focus<sup>TM</sup> lenses. It is the authors' hope that this handbook will play a useful role in the practice of XPS.

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# I. X-ray Photoelectron Spectroscopy



## A. Introduction

X-ray Photoelectron Spectroscopy (XPS) was developed in the mid-1960s by Kai Siegbahn and his research group at the University of Uppsala, Sweden. The technique was first known by the acronym ESCA (Electron Spectroscopy for Chemical Analysis). The advent of commercial manufacturing of surface analysis equipment in the early 1970s enabled the placement of equipment in laboratories throughout the world. In 1981, Siegbahn was awarded the Nobel Prize for Physics for his work with XPS.

This handbook is meant to furnish the user with much of the information necessary to use XPS for diverse types of surface analysis. Information is provided on methods of sample preparation, data gathering, elemental identification, chemical state identification, quantitative calculation and elemental distribution.

Surface analysis by XPS involves irradiating a solid *in vacuo* with monoenergetic soft x-rays and analyzing the emitted

electrons by energy. The spectrum is obtained as a plot of the number of detected electrons per energy interval versus their kinetic energy. Each element has a unique spectrum. The spectrum from a mixture of elements is approximately the sum of the peaks of the individual constituents. Because the mean free path of electrons in solids is very small, the detected electrons originate from only the top few atomic layers, making XPS a unique surface-sensitive technique for chemical analysis. Quantitative data can be obtained from peak heights or peak areas, and identification of chemical states often can be made from exact measurement of peak positions and separations, as well as from certain spectral features.

Included in this handbook are survey spectra, strong line spectra and x-ray excited Auger spectra for most of the elements and some of their compounds, in addition to plots and tables of energy shift data which aid in the identification of chemical states.

## B. Principles of the Technique

Surface analysis by XPS is accomplished by irradiating a sample with monoenergetic soft x-rays and analyzing the energy of the detected electrons. Mg K $\alpha$  (1253.6 eV) or Al K $\alpha$  (1486.6 eV) x-rays are usually used. These photons have limited penetrating power in a solid on the order of 1-10 micrometers. They interact with atoms in the surface region, causing electrons to be emitted by the photoelectric effect. The emitted electrons have measured kinetic energies given by:

$$KE = h\nu - BE - \phi_s \quad (1)$$

where  $h\nu$  is the energy of the photon, BE is the binding energy of the atomic orbital from which the electron originates, and  $\phi_s$  is the spectrometer work function.

The binding energy may be regarded as the energy difference between the initial and final states after the photoelectron has left the atom. Because there is a variety of possible final states of the ions from each type of atom, there is a corresponding variety of kinetic energies of the emitted electrons. Moreover, there is a different probability or cross-section for each final state. Relative binding energies and ionization cross-sections for an atom are shown schematically in Figure 1. The Fermi level corresponds to zero binding energy (by definition), and the depth beneath the Fermi level in the figure indicates the relative energy of the ion remaining after electron emission, or the binding energy of the electron. The line lengths indicate the relative probabilities of the various ionization processes. The p, d and f levels become split upon ionization, leading to vacancies in the  $p_{1/2}$ ,  $p_{3/2}$ ,  $d_{3/2}$ ,  $d_{5/2}$ ,  $f_{5/2}$  and  $f_{7/2}$ . The spin-orbit splitting ratio is 1:2 for p levels, 2:3 for d levels and 3:4 for f levels. As an example, the spin-orbit splitting of the Si 2p is shown in Figure 2.

Because each element has a unique set of binding energies, XPS can be used to identify and determine the concentration of the elements in the surface. Variations in the elemental binding energies (the chemical shifts) arise from differences in the chemical potential and polarizability of compounds. These

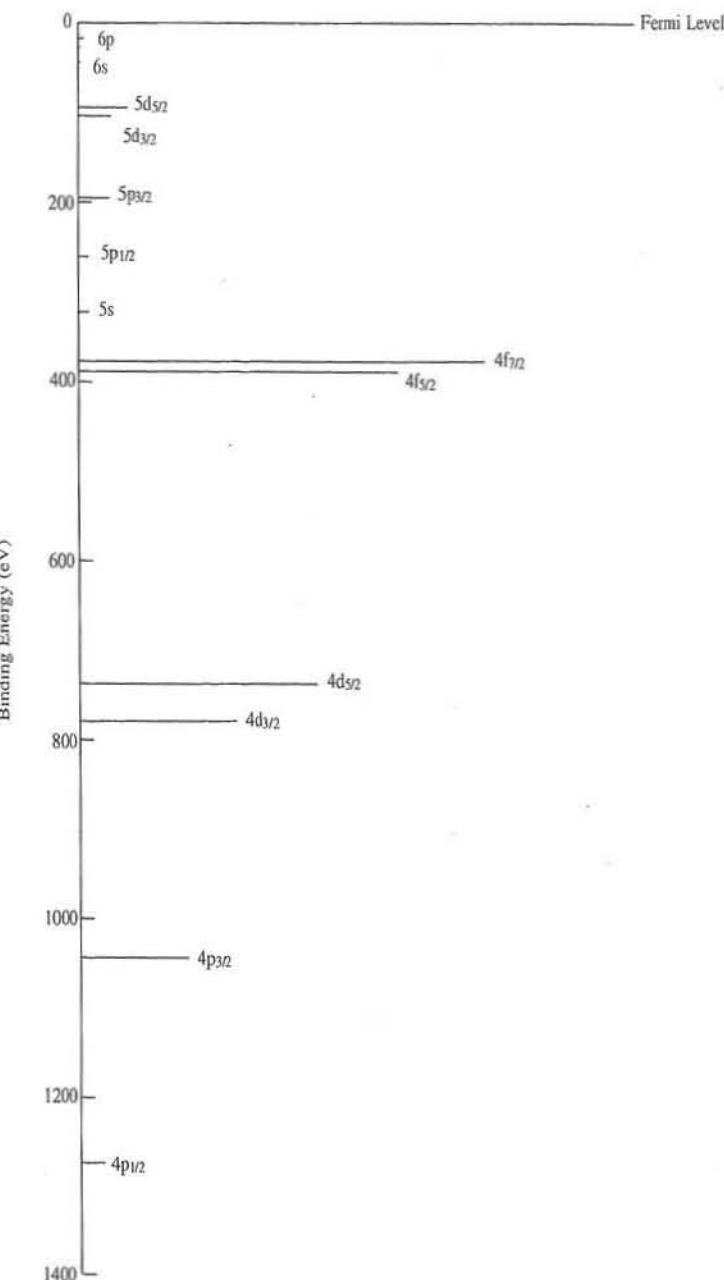


Figure 1. Relative binding energies and ionization cross-sections for U. The binding energy is proportional to the distance below the line indicating the Fermi level, and the ionization cross-section is proportional to the length of the line.

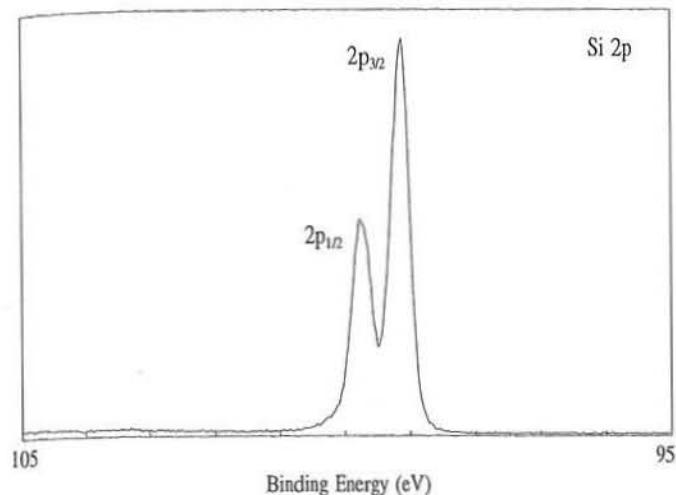


Figure 2. High-resolution spectrum of single-crystal Si showing the spin-orbit splitting of the 2p level.

chemical shifts can be used to identify the chemical state of the materials being analyzed.

In addition to photoelectrons emitted in the photoelectric process, Auger electrons may be emitted because of relaxation of the excited ions remaining after photoemission. This Auger electron emission occurs roughly  $10^{-14}$  seconds after the photoelectric event. The competing emission of a fluorescent x-ray photon is a minor process in this energy range. In the Auger process (Figure 3), an outer electron falls into the inner orbital vacancy, and a second electron is simultaneously emitted, carrying off the excess energy. The Auger electron possesses kinetic energy equal to the difference between the energy of the initial ion and the doubly charged final ion, and is independent of the mode of the initial ionization. Thus, photoionization normally leads to two emitted electrons — a photoelectron and an Auger electron. The sum of the kinetic energies of the electrons emitted cannot exceed the energy of the ionizing photons.

Probabilities of electron interaction with matter far exceed those of the photons, so while the path length of the photons is of the order of micrometers, that of the electrons is of the order of tens of angstroms. Thus, while ionization occurs to a depth of a few micrometers, only those electrons that originate within tens of

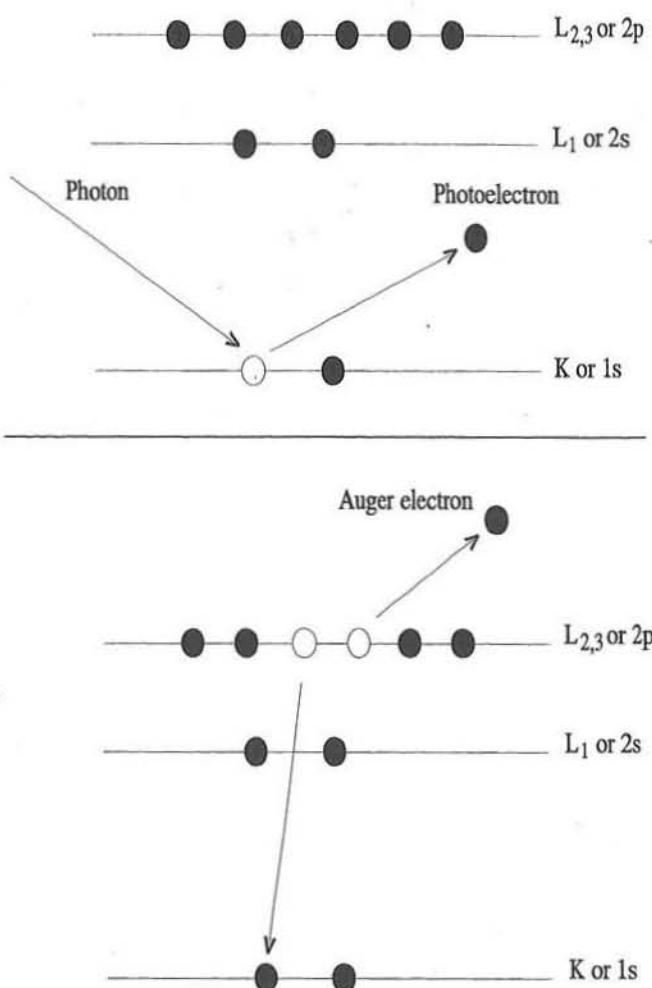


Figure 3. The XPS emission process (top) for a model atom. An incoming photon causes the ejection of the photoelectron. The relaxation process (bottom) for a model atom resulting in the emission of a  $KL_{2,3}L_{2,3}$  electron. The simultaneous two-electron coulombic rearrangement results in a final state with two electron vacancies.

angstroms below the solid surface can leave the surface without energy loss. These electrons which leave the surface without energy loss produce the peaks in the spectra and are the most useful. The electrons that undergo inelastic loss processes before emerging form the background. Calculations of the inelastic mean free paths of electrons in various materials are shown in Figure 4.

The electrons leaving the sample are detected by an electron spectrometer according to their kinetic energy. The analyzer is usually operated as an energy window, referred to as the pass energy, accepting only those electrons having an energy within the range of this window. To maintain a constant energy resolution, the pass energy is fixed. Incoming electrons are adjusted to the pass energy before entering the energy analyzer. Scanning for different energies is accomplished by applying a variable electrostatic field before the analyzer. This retardation voltage may be varied from zero up to and beyond the photon energy. Electrons are detected as discrete events, and the number of electrons for a given detection time and energy is stored and displayed.

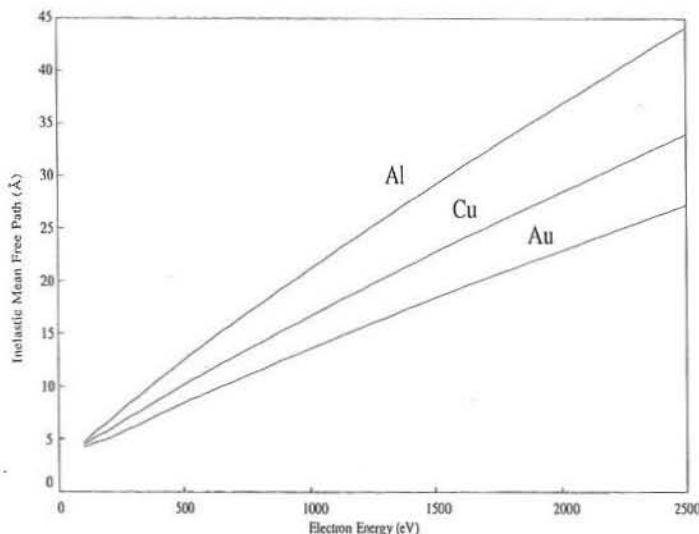


Figure 4. Calculated inelastic electron mean free paths in various metals from the method of S. Tanuma, C.J. Powell and D.R. Penn, *Surf. Interface Anal.* 17, 911 (1991).

## C. Preparing and Mounting Samples

In the majority of XPS applications, sample preparation and mounting are not critical. Typically, the sample is mechanically attached to the specimen mount, and analysis is begun with the sample in the as-received condition. Additional sample preparation is discouraged in many cases because any preparation might modify the surface composition. For those samples where special preparation or mounting cannot be avoided, the following techniques are recommended.

### 1. Removing Volatile Material

Ordinarily, volatile material is removed from the sample before analysis. In exceptional cases, when the volatile layer is of interest, the sample may be cooled for analysis. The cooling must be to a sufficiently low temperature to guarantee that the volatile element is not warmed to evaporation by any heat load that the analysis conditions may impart.

Removal of unwanted volatile materials is usually accomplished by long-term pumping in a separate vacuum system or by washing with a suitable solvent. Use freshly distilled solvent to avoid contamination by high boiling point impurities within the solvent. Choice of the solvent can be critical. Hexane or other light hydrocarbon solvents are probably least likely to alter the surface, providing the solvent properties are satisfactory. Samples may also be washed efficiently in a Soxhlett extractor using a suitable solvent.

### 2. Removing Nonvolatile Organic Contaminants

When the nature of an organic contaminant is not of interest or when a contaminant obscures underlying material that is of interest, the contaminant may be removed with appropriate organic solvents. As with volatile materials, the choice of solvent can be critical.

### 3. Surface Etching

Ion sputter-etching or other erosion techniques, such as the use of an oxygen plasma on organic materials (see Section E.5.a.(3), p. 27), may be used to remove surface contaminants. This technique is particularly useful when removing adventitious hydrocarbons from the sample or when the native oxides, formed by exposure to the atmosphere, are not of interest.

Argon ion etching is commonly used to obtain information on composition as a function of the exposure time to ion etching. Calibration of the sputter rates can be used to convert sputter time to information on depth into the specimen. Because sputtering may cause changes in the surface chemistry, identification of the changes in chemical states with depth may not reflect the true composition.

### 4. Abrasion

Abrasion of a surface can be done without significant contamination by using a laboratory wipe, a cork, a file or a knife blade. This may cause local heating, and reaction with environmental gases may occur (e.g., oxidation in air and formation of nitrides in nitrogen). To prevent oxidation of more active materials, perform abrasion in an inert atmosphere such as a glove box. The abraded material should then be transferred to the ultra-high vacuum (UHV) chamber in a sealed vessel to preserve the clean surface.

### 5. Fracturing and Scraping

With proper equipment, many materials can be fractured or scraped within the test chamber under UHV conditions. While this obviates contamination by reaction with atmospheric gases, attention must be given to unexpected results which might occur. Fracturing might occur along the grain boundaries which may not be representative of the bulk material. Scraping can cover hard material with soft material when the sample is multi-phase.

### 6. Grinding to Powder

If spectra characteristic of bulk composition are desired, samples may be ground to a powder in a mortar. Protection of the fresh surfaces from the atmosphere is required. When grinding samples, localized high temperatures can be produced, so grinding should be done slowly to minimize heat-induced chemical changes at the newly created surfaces. The mortar should be well cleaned before reuse.

### 7. Mounting Powders for Analysis

There are a number of methods which can be used to mount powders for analysis. Perhaps the most widely used method is dusting the powder onto a polymer-based adhesive tape with a camel-hair brush. The powder must be dusted across the surface carefully and lightly, with no wiping strokes. Some researchers shun organic tape for UHV work, but others have successfully used certain types of tape in the  $10^{-10}$  Torr range.

Alternative methods for mounting powders include pressing the powder into indium or other soft foils, supporting the powder on a metallic mesh, pressing the powder into pellets or simply depositing the powder by gravity. With the foil method, the powder is pressed between two pieces of pure foil. The pieces are then separated, and one of them is mounted for analysis. Success with this technique has been varied. Sometimes bare foil remains exposed and, if the sample is an insulator, parts of the powder can charge differently. Differential charging can also be a problem when a metallic mesh is used to support the powder. If a press is used to form the powder into a pellet of workable dimensions, a press with hard and extremely clean working surfaces should be used. Gravity can effectively hold some materials in place, particularly if a shallow well or depression is cut in the surface of the sample mount. Allowing a liquid suspension of the powder to dry on the specimen holder is an effective way of producing a

uniform layer. With these methods, care must be taken in pump-down to ensure that gas evolution does not disturb

the sample. A throttled roughing valve is especially effective.

## D. Experimental Procedure

### 1. Technique for Obtaining Spectra

All spectra in this handbook were obtained using a PHI Model 5600 MultiTechnique system. A schematic diagram of the apparatus (Figure 5) illustrates the relationship of major components, including the electron energy analyzer, the x-ray source, and the ion gun used for sputter-etching. The Model 10-360 Electron Energy Analyzer incorporated into the 5600 is an SCA, and the input lens to the analyzer is an Omni Focus III lens. The excitation sources used were a Model 10-550 x-ray source with a Model 10-410 monochromator and a Model 04-548 dual-anode source which was used with a magnesium anode. All of the spectra in the handbook were taken with the x-ray source operating at 400 W (15 kV - 27 mA). The specimens were analyzed at an electron take-off angle of 70°, measured with respect to the surface plane. The monochromatic x-ray source is located perpendicular to the analyzer axis, and the standard x-ray source is located at 54.7° relative to the analyzer axis.

In the PHI Model 5600 MultiTechnique system, energy distribution, energy resolution and analysis area are all a function of the analyzer. For all of the spectra in this handbook, the spectrometer was operated in a standard mode. The Omni Focus III lens was used to scan the spectrum while the SCA was operated at a constant pass energy. This resulted in constant resolution ( $\Delta E$ ) across the entire energy spectrum. The size of the analysis area was defined by the aperture selection of the Omni Focus III lens. Analyzer energy resolution ( $\Delta E/E$ ) was determined by the choice of pass energy and the selected

aperture. All of the spectra in this handbook were obtained using an 800  $\mu\text{m}$  diameter analysis area.

All of the spectra in this handbook were recorded and stored using the PHI ACCESS™ data system. The instrument was calibrated daily, and the calibration was checked several times each day during data acquisition. The analyzer work function was determined assuming the binding energy of the Au 4f<sub>7/2</sub> peak to be 84.0 eV. All survey spectra scans were taken at a pass energy of 58.7 eV. The narrow scans of strong lines were, in most cases, just wide enough to encompass the peak(s) of interest and were obtained with a pass energy of 23.5 eV. A lower pass energy may show more structure for some materials. The narrow spectra were necessary to accurately determine the energy, shape and spin-orbit splitting of the strong lines. On insulating samples, a high-resolution spectrum was taken of the adventitious hydrocarbon on the surface of the sample to use as a reference for charge correction. The generally accepted binding energy for adventitious carbon is 284.8 eV.

The samples analyzed to obtain the spectra in this handbook are standard materials of known composition. Metal foils and polycrystalline materials with large surface areas were mechanically fastened to the specimen mount. Powder samples were ground with a mortar and pestle to expose fresh surfaces and were dusted onto adhesive tape. Most elemental standards were sputter-etched immediately prior to analysis to remove surface contamination. Most compounds, however, were ground or cleaved, and the freshly exposed surface was analyzed

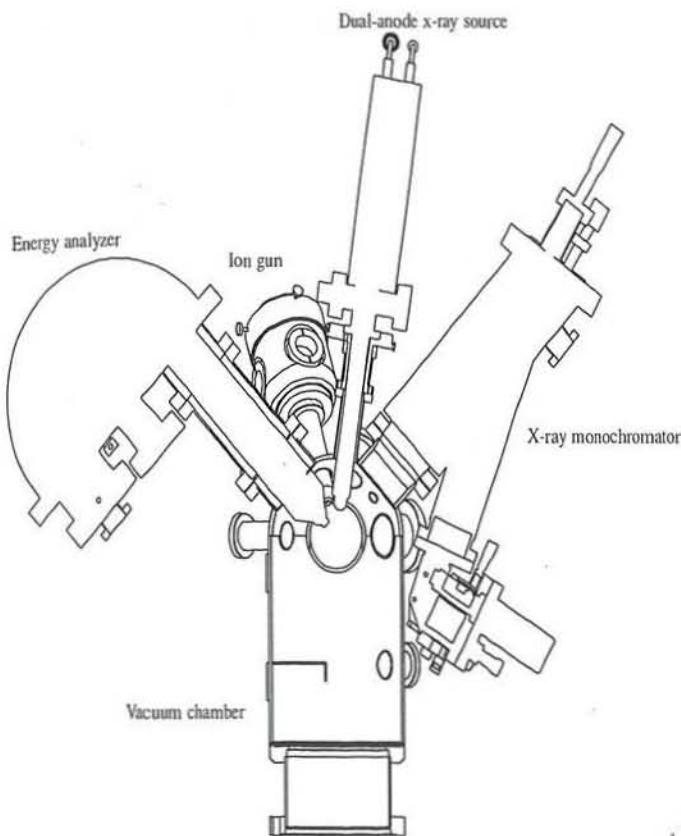


Figure 5. A schematic diagram of the PHI Model 5600 MultiTechnique system.

without etching in order to avoid possible changes in surface chemistry. Ne, Xe and Kr were implanted in graphite and Ar in silicon via ion implantation to unknown concentrations prior to analysis.

## 2. Instrument Calibration

To ensure the accuracy of the data presented in this handbook, the instrument used to obtain the data was calibrated regularly throughout the data-gathering process. The best way to check calibration, and the method used here, is to record suitable lines from a known, conducting specimen. Typically, the Au 4f or Cu 2p and 3p lines are used. The lines should be recorded with a narrow sweep width in the range of 5-10 eV, and

a pass energy of 23.5 eV or less (corresponding to the pass energy normally used for high resolution scans) should be used.

There is general agreement on accurate values of Cu, Au and Ag standard line energies. The values in Table 1 are recommended for clean Au, Ag and Cu:

Table 1. Reference Binding Energies (eV)

	Al K $\alpha$	Mg K $\alpha$
Cu 3p	75.14	75.13
Au 4f <sub>7/2</sub>	83.98	84.00
Ag 3d <sub>5/2</sub>	368.26	368.27
Cu L <sub>3</sub> MM	567.96	334.94
Cu 2p <sub>3/2</sub>	932.67	932.66
Ag M <sub>4</sub> NN	1128.78	895.75

from M. P. Seah *Surf. Interface Anal.* **14**, 488 (1989)

Because the 2p<sub>3/2</sub> and 3p<sub>3/2</sub> photoelectron peak energies of Cu are widely separated in energy, measurement of these peak binding energies provides a quick and simple means of checking the accuracy of the binding energy scale. Utilizing all of the above standard energies establishes the linearity of the energy scale and its position, i.e., the location of the Fermi level.

## 3. Programming Scans for an Unknown Sample

For a typical XPS investigation where the surface composition is unknown, a broad scan survey spectrum should be obtained first to identify the elements present. Once the elemental composition has been determined, narrower detailed scans of selected peaks can be used for a more comprehensive picture of the chemical composition. This is the procedure that has been followed in compiling data for this handbook, even though specimen composition was known prior to analysis.

**a. Survey Scans.** Most elements have major photoelectron peaks below 1100 eV, and a scan range from 1100-0 eV binding energy is usually sufficient to

identify all detectable elements. The spectra in this handbook were recorded with a scan range of 1400-0 eV (Al excitation) or 1200-0 eV (Mg excitation) binding energy. In an unknown sample, if specific elements are suspected at low concentrations, their standard spectra should be consulted before programming the survey scan. If the strongest line occurs above 1100 eV binding energy, the scan range can be modified accordingly.

An analyzer pass energy of 187 eV, in conjunction with the appropriate aperture, is recommended for survey scans with the PHI Model 5600 MultiTechnique system. These settings result in adequate resolution for elemental identification and produce very high signal intensities, minimizing data acquisition time and maximizing elemental detectability.

**b. Detail Scans.** For purposes of chemical state identification, for quantitative analysis of minor components and for peak deconvolution or other mathematical manipulations of the data, detail scans must be obtained for precise peak location and for accurate registration of line shapes. There are some logical rules for this programming.

(1) Scans should be wide enough to encompass the background on both sides of the region of in-

terest, yet with small enough step sizes to permit determination of the exact peak position. Sufficient scanning must be done within the time limits of the analysis in order to obtain good counting statistics.

(2) Peaks from any species thought to be radiation-sensitive or transient should be run first. Otherwise, any convenient order may be chosen.

(3) No clear guidelines can be given on the maximum duration of data gathering on any one sample. It should be recognized, however, that chemical states have vastly varying degrees of radiation sensitivity and that for any one set of irradiation conditions, there exists for many samples a condition beyond which it is impractical to attempt gathering data.

(4) With the PHI Model 5600 MultiTechnique system, an analyzer pass energy of 23 eV is normally used for routine detail scans. Where higher energy resolution is needed, lower pass energies can be utilized. For example, the sputter-cleaned Si 2p on p. 56, taken at 23 eV pass energy, can be compared to the chemically etched Si 2p shown in Figure 2 (p. 11).

## E. Data Interpretation

### 1. The Nature of the Spectrum

**a. General Features.** The spectrum is displayed as a plot of the number of electrons versus electron binding energy in a fixed, small energy interval. The position on the kinetic energy scale equal to the photon excitation energy minus the spectrometer work function cor-

responds to a binding energy of 0 eV with reference to the Fermi level (Equation 1, p. 10). Therefore, a binding energy scale with 0 at that point and increasing to the left is customarily used.

The spectra in this handbook are typical for the various elements. The well-defined peaks are due to electrons

which have not suffered an inelastic energy loss emerging from the sample. Electrons that have lost energy increase the level of the background at binding energies higher than the peak energy. The background is continuous because the energy loss processes are random and multiple. The background in the Mg K $\alpha$  induced spectra is larger than the background in the monochromated Al K $\alpha$  induced spectra because of excitation by Bremsstrahlung radiation of the non-monochromated light.

The "noise" in the spectrum is not instrumental in origin but is the consequence of the collection of single electrons as counts randomly spaced in time. The standard deviation for counts collected in any channel is equal to the square root of the counts so that the percent standard deviation is  $100/(\text{counts})^{1/2}$ . The signal-to-noise ratio is then proportional to the square root of the counting time. The background level upon which the peak is superimposed is a characteristic of the specimen, the excitation source and the transmission characteristics of the instrument.

**b. Types of Lines.** Several types of peaks are observed in XPS spectra. Some are fundamental to the technique and are always observed. Others are dependent upon the exact physical and chemical nature of the sample. A third type is the result of instrumental effects. The following describes the various spectral features that are likely to be encountered:

(1) *Photoelectron Lines.* The most intense photoelectron lines are relatively symmetrical and are typically the narrowest lines observed in the spectra. Photoelectron lines of pure metals can, however, exhibit considerable asymmetry due to coupling with conduction electrons. Peak width is a convolution of the natural line width (the lifetime of the "hole" resulting from the photoionization process), the width of the x-ray line which created the photoelectron line and the in-

strumental contribution to the observed line width. Less intense photoelectron lines at higher binding energies are usually wider by 1-4 eV than the lines at lower binding energies. All of the photoelectron lines of insulating solids are of the order of 0.5 eV wider than photoelectron lines of conductors. The approximate binding energies of all photoelectron lines detectable by Al or Mg radiation are cataloged in Appendices G and H.

(2) *Auger Lines.* These are groups of lines in rather complex patterns. There are four main Auger series observable in XPS. They are the KLL, LMM, MNN and NOO series, identified by specifying the initial and final vacancies in the Auger transition. The KLL series, for example, includes those processes with an initial vacancy in the K shell and final double vacancy in the L shell. The symbol V (e.g., KVV) indicates that the final vacancies are in valence levels. The KLL series has, theoretically, nine lines, and others have still more. Because Auger lines have kinetic energies which are independent of the ionizing radiation, they appear on a binding energy plot to be in different positions when ionizing photons of different energies (i.e., different x-ray sources) are used. Core-type Auger lines (with final vacancies deeper than the valence levels) usually have at least one component of intensity similar to the most intense photoelectron line. Positions of the more prominent Auger components are cataloged along with the photoelectron peaks in Appendices G and H.

(3) *X-ray Satellites.* The x-ray emission spectrum from a nonmonochromatic source used for irradiation exhibits not only the characteristic x-ray but also some minor x-ray components at higher photon energies. For each photoelectron peak that results from the routinely used Mg and Al K $\alpha$  x-

ray photons, there is a family of minor peaks at lower binding energies, with intensity and spacing characteristic of the x-ray anode material. The pattern of such satellites for Mg and Al is shown in Table 2. A resultant spectrum using Mg x-rays is shown in Figure 6.

Table 2. X-ray Satellite Energies and Intensities

	$\alpha_{1,2}$	$\alpha_3$	$\alpha_4$	$\alpha_5$	$\alpha_6$	$\beta$
Mg displacement, eV	0	8.4	10.1	17.6	20.6	48.7
relative height	100	8.0	4.1	0.6	0.5	0.5
Al displacement, eV	0	9.8	11.8	20.1	23.4	69.7
relative height	100	6.4	3.2	0.4	0.3	0.6

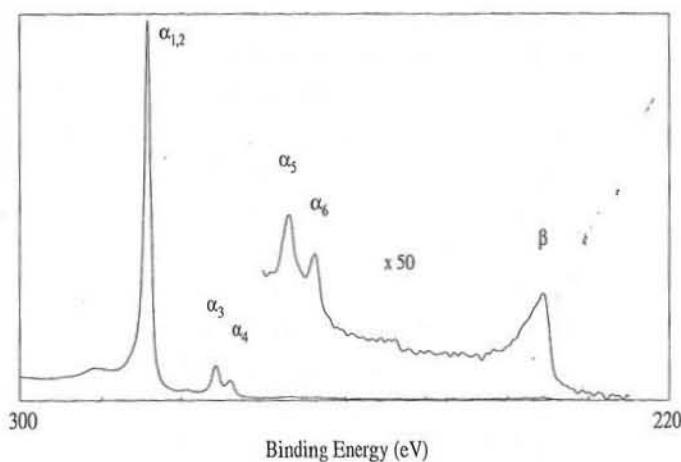


Figure 6. Mg x-ray satellites observed in the C 1s spectrum of graphite.

(4) *X-ray Ghost Lines.* Occasionally, x-radiation from an element other than the x-ray source anode material impinges upon the sample, resulting in small peaks corresponding to the most intense spectral peaks but displaced by a characteristic energy interval. These lines may result from Mg impurity in the Al anode or vice versa, Cu from the anode base structure, oxidation of the anode, or generation of x-ray photons in the Al foil x-ray window. On occasion, such lines can originate via

generation of x-rays within the sample itself. This last possibility is rare because the probability of x-ray emission is low relative to Auger electron emission. Nevertheless, such minor lines can be puzzling. Table 3 indicates where such peaks are most likely to occur relative to the most intense photoelectron lines. Because such ghost lines rarely appear with nonmonochromatic x-ray sources and are not possible with monochromatic x-ray sources, they should not be considered in line identification until all other possibilities are excluded.

Table 3. Displacement of X-ray Ghost Lines (eV)

Contaminating Radiation	Anode Material
Mg	Al
O (K $\alpha$ )	728.7
Cu (L $\alpha$ )	323.9
Mg (K $\alpha$ )	—
Al (K $\alpha$ )	-233.0

(5) *Shake-Up Lines.* Not all photoelectric processes are simple ones which lead to the formation of ions in the ground state, but there is a finite probability that the ion will be left in an excited state a few electron volts above the ground state. In this event, the kinetic energy of the emitted photoelectron is reduced, with the difference corresponding to the energy difference between the ground state and the excited state. This results in the formation of a satellite peak a few electron volts lower in kinetic energy (higher in binding energy) than the main peak. For example, the characteristic shake-up line for carbon in aromatic compounds, a shake-up process involving the energy of the  $\pi \rightarrow \pi^*$  transition, is shown in Figure 7.

In some cases, most often with paramagnetic compounds, the intensity of the shake-up satellite may

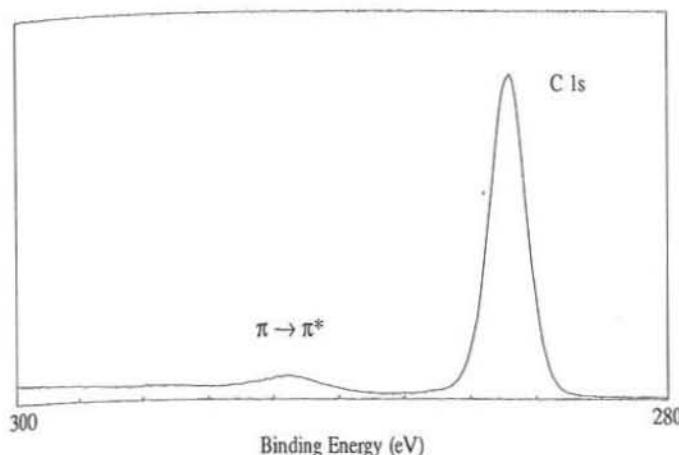


Figure 7. The  $\pi$  bond shake-up satellite for C 1s in polystyrene. The peak is about 6.7 eV higher than the main photopeak.

approach that of the main line. More than one satellite of a principal photoelectron line can also be observed, as shown in Figure 8. The occurrence of such lines is sometimes also apparent in Auger spectral contours (Figure 9). The displacements and relative intensities of shake-up satellites can sometimes be useful in identifying the chemical state of an element, as discussed in Section E.3.d. (p. 24).

(6) *Multiplet Splitting.* Emission of an electron from a core level of an atom that itself has a spin (unpaired electrons in valence levels) can create a vacancy in two or more ways. The coupling of the new unpaired electron left after photoemission from an s-type orbital with other unpaired electrons in the atom can create an ion with several possible final state configurations and as many energies. This results in a photoelectron line which is split asymmetrically into several components similar to the one shown in Figure 10.

Multiplet splitting also occurs in the ionization of p levels, but the result is more complex and subtle. In favorable cases, it results in an apparent slight

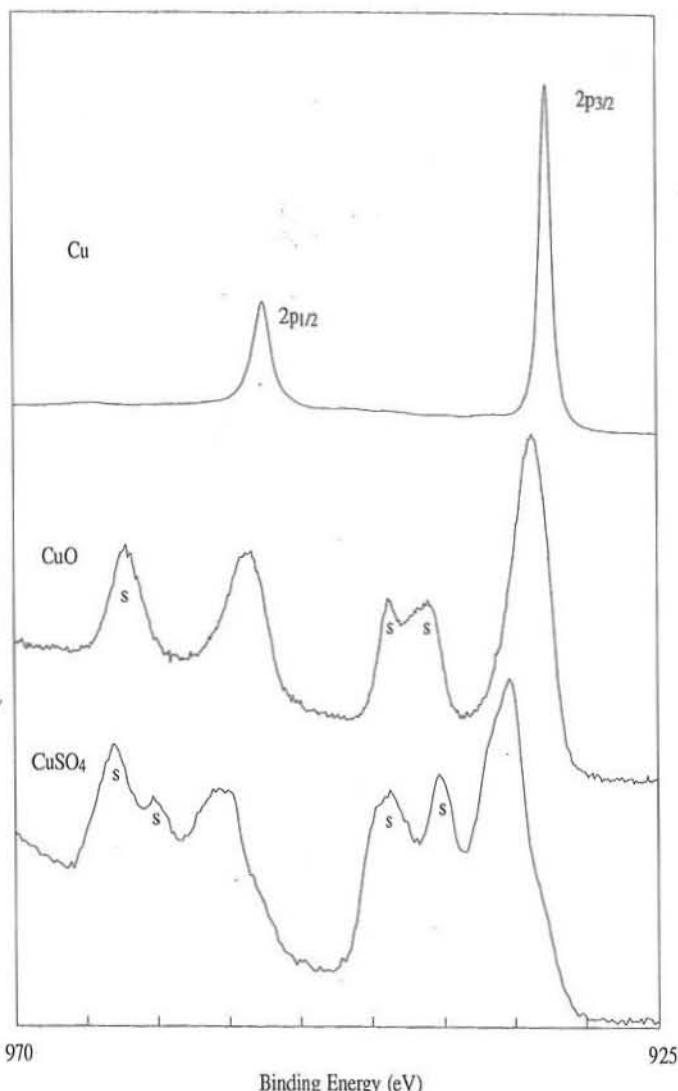


Figure 8. Examples of shake-up lines (s) of the copper 2p observed in copper compounds.

increase in the spin doublet separation, evidenced in the separation of the 2p<sub>1/2</sub> and 2p<sub>3/2</sub> lines in first-row transition metals, and in the generation of a less easily noticed asymmetry in the line shape of the components. Often such effects on the p doublet are obscured by shake-up lines.

(7) *Energy Loss Lines.* With some materials, there is an enhanced probability for loss of a specific

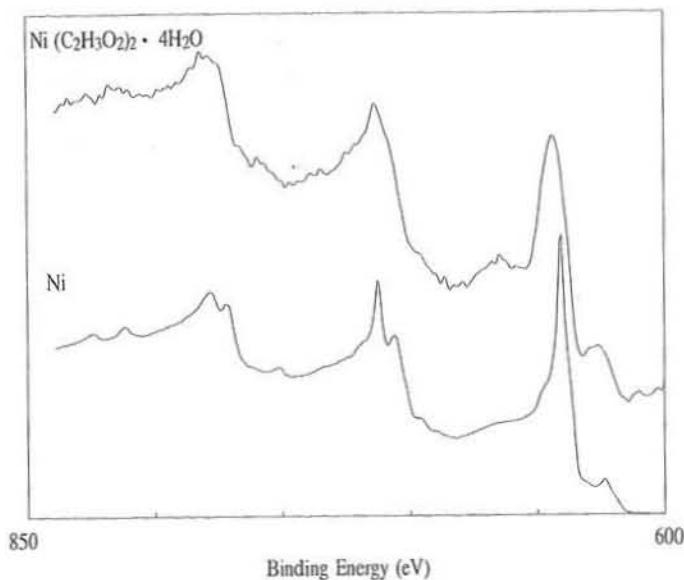


Figure 9. Examples of the effects of chemical states on Auger line shapes in nickel compounds.

amount of energy due to interaction between the photoelectron and other electrons in the surface region of the sample (Figure 11). The energy loss phenomenon produces a distinct and rather sharp hump 20-25 eV above the binding energy of the parent line. Under certain conditions of spectral display, energy loss lines can cause confusion. Such phenomena in insulators are rarely sharper than that shown in Figure 11 and are usually much more muted. They are different in each solid medium.

With metals, the effect is often much more dramatic, as indicated by the loss lines for aluminum shown in Figure 12. Energy loss to the conduction electrons occurs in well-defined quanta characteristic of each metal. These plasmons arise from group oscillations of the conduction electrons. The photoelectron line, or the Auger line, is successively mirrored at intervals of higher binding energy with reduced intensity. The energy

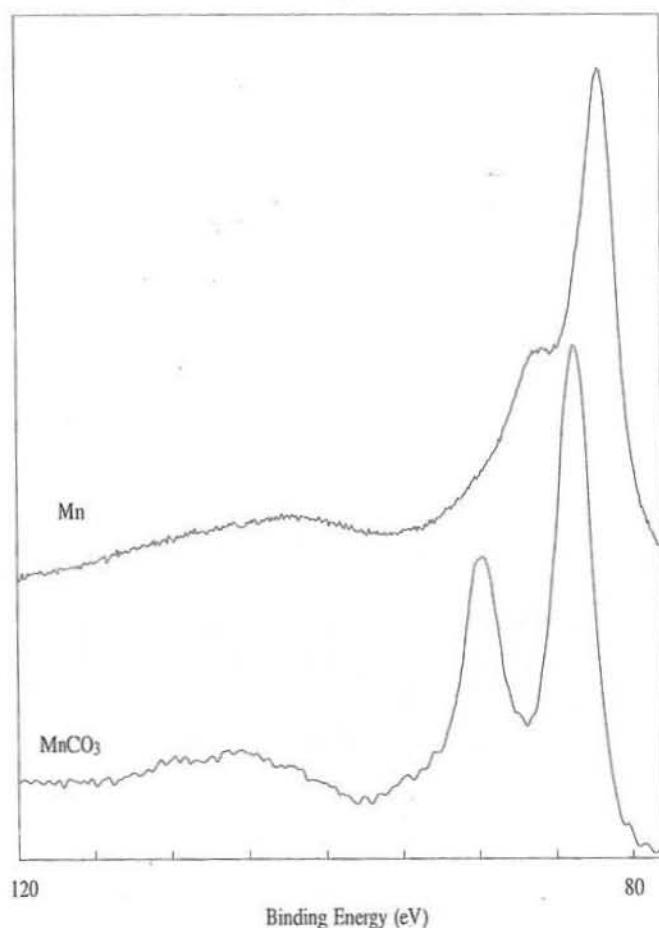


Figure 10. Multiplet splitting of the Mn 3s.

interval between the primary peak and the loss peak is called the plasmon energy. The so-called bulk plasmons are the more prominent of these lines. A second series, the surface plasmons, exists at energy intervals determined approximately by dividing the bulk plasmon energy by the square root of two. The effect is not easily observed in nonconductors, nor is it prominent in all conductors. Plasmon lines are especially prominent in the Groups Ia and Ila metal spectra in this handbook.

(8) *Valence Lines and Bands.* Lines of low intensity occur in the low binding energy region of the

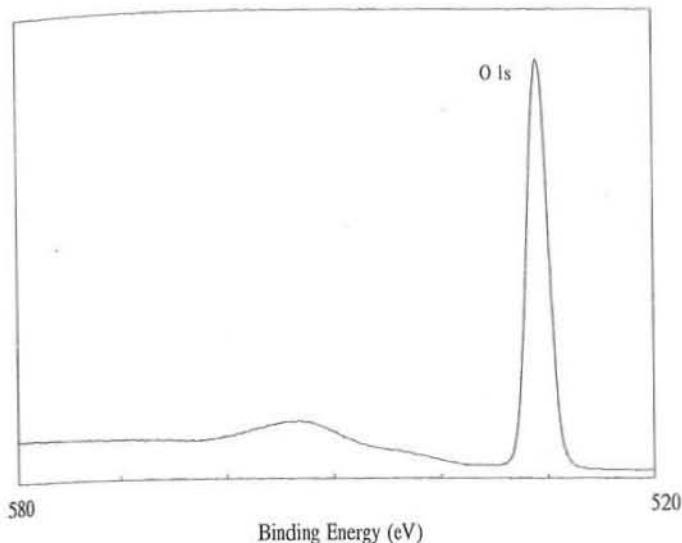


Figure 11. Energy loss envelope from the O 1s line in  $\text{Al}_2\text{O}_3$  (sapphire).

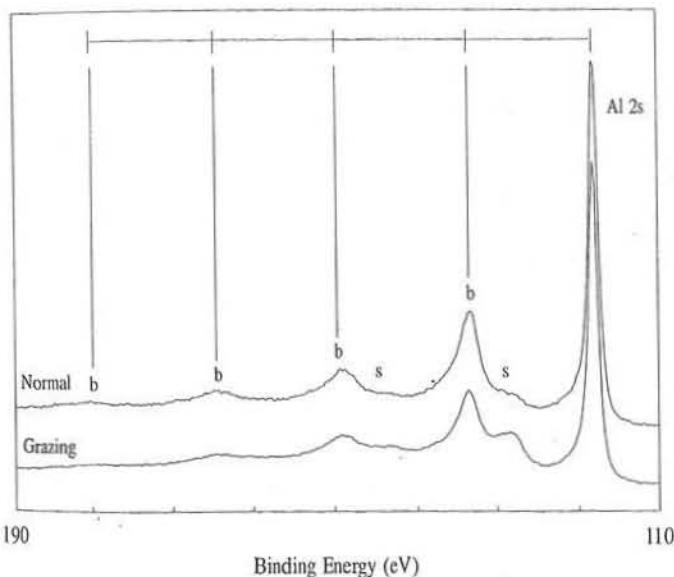


Figure 12. Surface (s) and bulk (b) plasmon lines associated with the Al 2s at normal and grazing take-off angles.

spectrum between the Fermi level and 10-20 eV binding energy. These lines are produced by photoelectron emission from molecular orbitals and from solid state energy bands. Differences be-

tween insulators and conductors are especially noted by the absence or presence of electrons from conduction bands at the Fermi level. Valence bands may also be used to distinguish between materials where the core level XPS photoelectron lines are quite similar in shape and position. Appendix D contains valence band spectra of several materials.

## 2. Line Identification

In general, interpretation of the XPS spectrum is most readily accomplished first by identifying the lines that are almost always present (specifically those of C and O), then by identifying major lines and associated weaker lines, and lastly by identifying the remaining weak lines. Most modern, commercially available spectrometers have peak identification algorithms within their data reduction packages. Poor signal-to-noise of the data or database limitations may require manual identification of some peaks. The following step-by-step procedure simplifies the data interpretation task and minimizes data ambiguities.

**Step 1.** The C 1s, O 1s, C (KLL) and O (KLL) lines are usually prominent in any spectrum. Identify these lines first along with all derived x-ray satellites and energy loss envelopes.

**Step 2.** Identify other intense lines (Appendix J) present in the spectrum, then label any related satellites and other less intense spectral lines associated with those elements. The energy positions of the less intense lines are noted in the line position table with the spectra. Keep in mind that some lines may be interfered with by more intense, overlapping lines from other elements. The most serious interferences by the C and O lines, for example, are Ru 3d by C 1s, V 2p and Sb 3d by O 1s, I (MNN) and Cr (LMM) by O (KLL), and Ru (MNN) by C (KLL).

**Step 3.** Identify any remaining minor lines. In doing this, assume they are the most intense lines of an unknown element. If not, they should already have been identified in the previous steps. Again, keep in mind possible line interferences. Small lines that seem unidentifiable can be ghost lines. Use Table 3 (p. 18) to check for the more intense parent photoelectron lines.

**Step 4.** Check the conclusions by noting the spin doublets for p, d and f lines. They should have the right separation (cf. spin orbit splitting for individual elements and Appendices G and H) and should be in the correct intensity ratio. The ratio for p lines should be about 1:2, d lines 2:3 and f lines 3:4. P lines, especially 4p lines, may be less than 1:2.

### 3. Chemical State Identification

The identification of chemical states primarily depends on the accurate determination of line energies. To determine line energies accurately, the voltage scale of the instrument must be precisely calibrated (cf. Section D.2., p. 15), a line with a narrow sweep range must be recorded with good statistics (of the order of several thousand counts-per-channel above background), and accurate correction must be made for static charge if the sample is an insulator.

**a. Determining Static Charge on Insulators.** During analysis, insulating samples tend to acquire a steady-state charge of as much as several volts. This steady-state charge is a balance between electron loss from the surface by emission and electron gain by conduction or by acquisition of slow or thermal electrons from the vacuum. The steady-state charge, usually positive, can be minimized with an adjacent neutralizer or flood gun. It is often advantageous to do this to reduce differential charging and sharpen the spectral lines.

A serious problem is exactly determining the extent of charging. Any positive charging retards outgoing

electrons and tends to make the peaks appear at higher binding energies, whereas excessive charge compensation can make the peaks shift to lower binding energies. The following are four methods which are usually valid for charge correction on insulating samples:

- (1) Measurement of the position of the C 1s line from adventitious hydrocarbon nearly always present on samples introduced from the laboratory environment or from the glove box. This line, on unsputtered inert metals such as Au or Cu, appears at 284.8 eV, so any shift from this value can be taken as a measure of the static charge. At this time, it is not known whether a reproducible line position exists for C remaining on the surface after ion beam etching.
- (2) The use of an internal standard, such as a hydrocarbon moiety of a polymer sample. For the study of supported catalysts or similar materials, one can adopt a suitable value for a constituent of the support and use that to interrelate binding energies of different samples. One must be certain that treatments of the various samples are not so different that the inherent binding energies of support constituents are changed.
- (3) The use of a normally insulating sample so thin that it effectively does not insulate. This can be assumed if the spectrum of the underlying conductor appears in good intensity and if line positions are not affected by changes in electron flux from the charge neutralizer.
- (4) For the study of insulating polymer films, binding energies of the C functional groups may also be determined by applying a small amount of poly(dimethyl siloxane) solution ( $10^{-6}$  M) to the sample surface and charge reference to the Si 2p of the silicone (at about 102.1 eV).



Some precautions should be kept in mind. If the sample is heterogeneous on even a micrometer scale, particles of different materials can be charged to different extents, and interpretation of the spectrum is complicated accordingly. One cannot physically mix a conducting standard like Au or graphite of micron dimensions with a powder and validly use the Au or graphite line in order to correct for static charge. Differential charging can be minimized to a great extent by using a flood source of low-energy electrons.

**b. Photoelectron Line Chemical Shifts and Separations.** An important advantage of XPS is its ability to obtain information on chemical states from the variations in binding energies, or chemical shifts, of the photoelectron lines. While many attempts have been made to calculate chemical shifts and absolute binding energies, the factors involved (especially in the solid state) are imperfectly understood, and one must rely on experimental data from standard materials. The tables accompanying the spectra in this handbook record considerable data from the literature as well as data obtained specifically for this handbook. All literature data have been carefully evaluated to the instrumental calibration and static charge reference values given above and are, therefore, directly comparable.

Because occasional line interferences do occur, it is sometimes necessary to use a line other than the most intense one in the spectrum. Chemical shifts of a minor line are within 0.2 eV of the chemical shift of the primary line. However, exceptional separations can occur in paramagnetic materials because of multiplet splitting. Separations of photoelectron lines can be determined approximately from the line position tables in Appendices G and H.

**c. Auger Line Chemical Shifts and the Auger Parameter.** Core-type Auger lines (transitions ending with double vacancies below the valence levels) usually have at least one component that is narrow and intense,

often nearly as intense as the strongest photoelectron line (cf. spectra for F, Na, As, In, Te and Pb). There are four core Auger groups that can be generated by Mg or Al x-rays: the KLL (Na, Mg); the LMM (Cu, Zn, Ga, Ge, As, Se); the MNN (Ag, Cd, In, Sn, Sb, Te, I, Xe, Cs, Ba); and NOO (Th, U). The MNN lines in the rare earths, while accessible, are very broad because of multiplet splitting and shake-up phenomena with most of the compounds. Valence-type Auger lines (final states with vacancies in valence levels) — such as those for O and F (KLL); Mn, Fe, Co and Ni (LMM); and Ru, Rh and Pd (MNN) — can be intense and are, therefore, also useful. Chemical shifts occur with Auger lines as well as with photoelectron lines. The chemical shifts are different from those of the photoelectron lines, but they are often more pronounced. This can be very useful for identifying chemical states, especially in combination with photoelectron chemical shift data. If data for the various chemical states of an element are plotted with the binding energy of the photoelectron line on the abscissa and the kinetic energy of the Auger line on the ordinate, a two-dimensional chemical state plot can be obtained. Such plots are in Appendix A for F, Na, Al, Si, S, Cu, Zn, As, Se, Ag, Cd, In, Sn and Te.

With chemical states displayed in two dimensions, the Auger parameter method becomes more powerful as a tool for identifying the chemical components than using photoelectron chemical shifts alone. In the format adopted for this handbook, the kinetic energy of the Auger line is plotted against the binding energy of the photoelectron line, with the latter plotted in the -x direction (kinetic energy is still, implicitly, +x). The kinetic energy of the Auger electron, referred to the Fermi level, is easily calculated by subtracting from the photon energy the position of the Auger line on the binding energy scale.

With this arrangement, each diagonal line represents all values of equal sums of Auger kinetic energy and

photoelectron binding energy. The Auger parameter,  $\alpha$ , is defined as,

$$\alpha = KE_A - KE_P = BE_P - BE_A \quad (2)$$

or as the difference in binding energy between the photoelectron and Auger lines. This difference can be accurately determined because static charge corrections cancel. With all kinetic and binding energies referenced to the Fermi level, and recalling that:

$$KE = h\nu - BE \quad (3)$$

then...

$$KE_A + BE_P = h\nu + \alpha \quad (4)$$

or the sum of the kinetic energy of the Auger line and the binding energy of the photoelectric line equals the Auger parameter plus the photon energy. A plot showing Auger kinetic energy versus photoelectron binding energy then becomes independent of the photon energy.

In general, polarizable materials, especially conductive materials, have a high Auger parameter, while insulating compounds have a lower Auger parameter.

#### d. Chemical Information from Satellite Lines and Peak Shapes

(1) *Shake-up Lines*. These satellite lines have intensities and separations from the parent photoelectron line that are unique to each chemical state (Figure 8, p. 19). Some Auger lines also exhibit radical changes with chemical state that reflect these processes (Figure 9, p. 20). With transition elements and rare earths, the absence of shake-up satellites is usually characteristic of the elemental or diamagnetic states. Prominent shake-up patterns typically occur with paramagnetic states. Table 4 is a guide to some expected paramagnetic states.

*Table 4. General Guide to Paramagnetic Species*

*Multiplet splitting and shake-up lines are generally expected in the paramagnetic states below:*

Atomic No.	Paramagnetic States	Diamagnetic States
22	Ti(II), Ti(III)	Ti(IV)
23	V(II), V(III), V(IV)	V(V)
24	Cr(II), Cr(III), Cr(IV), Cr(V)	Cr(VI)
25	Mn(II), Mn(III), Mn(IV), Mn(V)	Mn(VII)
26	Fe(II), Fe(III)	K <sub>4</sub> Fe(CN) <sub>6</sub> , Fe(CO) <sub>4</sub> Br <sub>2</sub>
27	Co(II), Co(III)	CoB, Co(NO <sub>2</sub> ) <sub>3</sub> NH <sub>3</sub> , K <sub>3</sub> Co(CN) <sub>6</sub> , Co(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>6</sub> , K <sub>2</sub> Ni(CN) <sub>4</sub> , square planar complexes
28	Ni(II)	Cu(I)
29	Cu(II)	Mo(VI), MoS <sub>2</sub> , K <sub>4</sub> Mo(CN) <sub>8</sub>
42	Mo(IV), Mo(V)	Ru(II)
44	Ru(III), Ru(IV), Ru(V)	Ag(I)
47	Ag(II)	Ce(IV)
58	Ce(III)	Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb compounds
59-70	W(IV), W(V)	W(VI), WO <sub>2</sub> , WCl <sub>4</sub> , WC, K <sub>4</sub> W(CN) <sub>8</sub>
75	Re(II), Re(III), Re(IV), Re(V), Re(VI)	Re(VII), ReO <sub>3</sub>
76	Os(III), Os(IV), Os(V)	Os(II), Os(VI), Os(VIII)
77	Ir(IV)	Ir(III)
92	U(III), U(IV)	U(VI)

(2) *Multiplet Splitting*. On occasion, the multiplet splitting phenomenon can also be helpful in identifying chemical states. The 3s lines in the first series of transition metals, for example, exhibit separations characteristic of each paramagnetic chemical state. The 3s line, however, is weak and therefore is not often useful analytically. The 2p doublet separation is also affected by multiplet splitting, and the lines are more intense. The effect becomes very evident with Co compounds where the separation varies up to 1 eV. When first-row transition metal compounds are under study, it is

useful to accurately record these line separations and make comparisons with model compounds.

(3) *Auger Line Shape.* Valence-type Auger transitions form final-state ions with vacancies in molecular orbitals. The distribution of the group of lines is strongly affected, therefore, by the nature of the molecular orbitals in the different chemical states. Although little has yet been tabulated on this subject, the spectroscopist should bear in mind the possible utility of Auger line shapes.

#### 4. Quantitative Analysis

For many XPS investigations, it is important to determine the relative concentrations of the various constituents. Methods have been developed for quantifying the XPS measurement utilizing peak area and peak height sensitivity factors. The method which utilizes peak area sensitivity factors typically is the more accurate and is discussed below. This approach is satisfactory for quantitative work. For transition metal spectra with prominent shake-up lines, it is best to include the entire 2p region when measuring peak area.

For a sample that is homogeneous in the analysis volume, the number of photoelectrons per second in a specific spectra peak is given by:

$$I = nf\sigma\theta y\lambda AT \quad (5)$$

where  $n$  is the number of atoms of the element per  $\text{cm}^3$  of the sample,  $f$  is the x-ray flux in photons/ $\text{cm}^2\text{-sec}$ ,  $\sigma$  is the photoelectric cross-section for the atomic orbital of interest in  $\text{cm}^2$ ,  $\theta$  is an angular efficiency factor for the instrumental arrangement based on the angle between the photon path and detected electron,  $y$  is the efficiency in the photoelectric process for formation of photoelectrons of the normal photoelectron energy,  $\lambda$  is the mean free path of the photoelectrons in the sample,  $A$  is the area of the sample from which photoelectrons

are detected, and  $T$  is the detection efficiency for electrons emitted from the sample. From Equation 5:

$$n = I/f\sigma\theta y\lambda AT \quad (6)$$

The denominator in Equation 6 can be defined as the atomic sensitivity factor,  $S$ . If we consider a strong line from each of two elements, then:

$$\frac{n_1}{n_2} = \frac{I_1/S_1}{I_2/S_2} \quad (7)$$

This expression may be used for all homogeneous samples if the ratio  $S_1/S_2$  is matrix-independent for all materials. It is certainly true that such quantities as  $\sigma$  and  $\lambda$  vary somewhat from material to material (especially  $\lambda$ ), but the ratio of each of the two quantities  $\sigma_1/\sigma_2$  and  $\lambda_1/\lambda_2$  remains nearly constant. Thus, for any spectrometer, it is possible to develop a set of relative values of  $S$  for all of the elements. Multiple sets of values may be necessary for instruments with multiple x-ray sources at different angles relative to the analyzer.

A general expression for determining the atom fraction of any constituent in a sample,  $C_x$ , can be written as an extension of Equation 7:

$$C_x = \frac{n_x}{\sum n_i} = \frac{I_x/S_x}{\sum I_i/S_i} \quad (8)$$

Values of  $S$  based on peak area measurements are indicated in Appendices E and F. The values of  $S$  in the appendices are based on empirical data (C.D. Wagner et al. *Surf. Interface Anal.* 3, 211 (1981)) which have been corrected for the transmission function of the spectrometer. The values in the appendix are only valid for and should only be applied when the electron energy analyzer used has the transmission characteristics of the SCA supplied by Perkin-Elmer. An example of the application of Equation 8 to analysis of a sample of

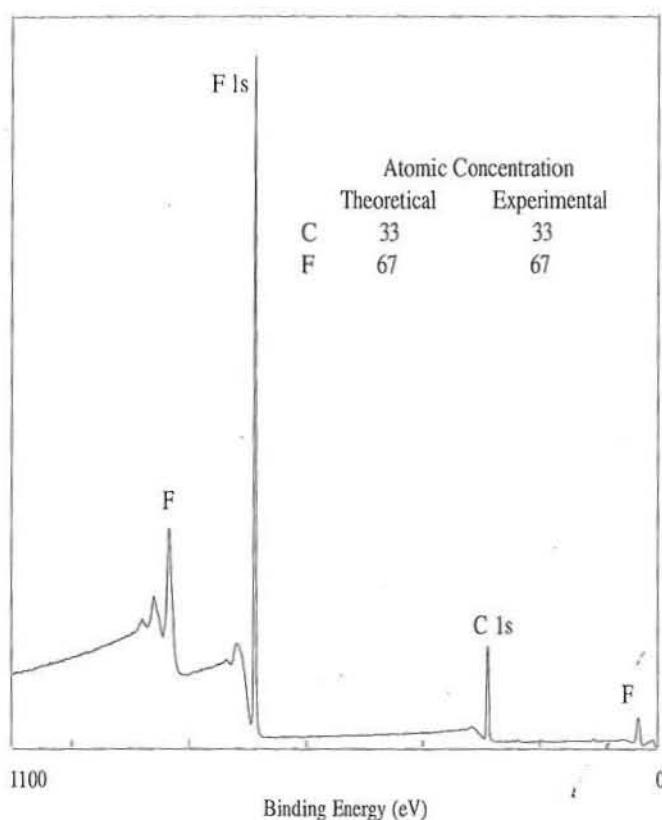


Figure 13. Quantitative analysis of poly(tetrafluoroethylene).

known composition, poly(tetrafluoroethylene), is shown in Figure 13.

The use of atomic sensitivity factors in the manner described will normally furnish semiquantitative results (within 10-20%), except in the following situations:

- The technique cannot be applied rigorously to heterogeneous samples. It can be useful with heterogeneous samples in measuring the relative number of atoms detected, but one must be conscious that the microscopic character of the heterogeneous system influences the quantitative results. Moreover, an overlying contamination layer has the effect of diminishing the intensity of high binding energy peaks more than that of low binding energy peaks.

b. Transition metals, especially of the first series, have widely varying and low values of  $y$ , whereas  $y$  for the other elements is rather uniform at about 0.8 eV. Thus, a value of  $S$  determined on one chemical state for a transition metal may not be valid for another chemical state. This effect can be minimized by including shake-up peaks in the area measurement.

c. When peak interferences occur, alternative lines must sometimes be used. The ratios of spin doublets (except 4p) are rather uniform, and the weaker of the pair can often be substituted. The spectra of the elements should be consulted, but caution must be exercised because the spectra of the elements themselves can be different from the spectra of their compounds.

d. Occasionally, an x-ray satellite from an intense photoelectron line interferes with measurement of a weak component. A mathematical approach can then be used to subtract the x-ray satellite before the measurement.

For quantitative work, check the spectrometer operation frequently to ensure that analyzer response is constant and optimum. A useful test is the recording of the three widely spaced spectral lines from Cu. Measurement of the peak height in counts-per-second should be made on 20-volt-wide scans of the  $2p_{3/2}$ , LMM Auger and 3p lines. Maintenance of such records makes it easy to notice if an instrument change occurs that would affect quantitative analysis.

## 5. Determining Element Location

- Depth.** There are four methods of obtaining information on the depth of an element in the sample. The first two methods described below utilize the characteristics of the spectrum itself but provide limited information. The third provides more detailed information but is attended by certain problems. The fourth utilizes measurements at two or more electron escape angles.

(1) The presence or absence of an energy loss peak or envelope indicates whether the emitting atoms are in the bulk or at the surface. Because electrons from surface atoms do not traverse the bulk, peaks from the surface atoms are symmetrical above level baselines on both sides, and the energy loss peak is absent. For a homogeneous sample, peaks from all elements will have similar inelastic loss structures.

(2) Elements whose spectra exhibit photoelectron lines widely spaced in kinetic energy can be approximately located by noting the intensity ratio of the lines. In the energy range above approximately 100 eV, electrons moving through a solid with lower kinetic energy are attenuated more strongly than those with higher kinetic energy. Thus, for a surface species, the low kinetic energy component will be relatively stronger than the high kinetic energy component, compared to that observed in the pure material. The data for homogeneous bulk solids can be compared with intensity ratios observed on unknowns to determine qualitatively the distribution of the element in the sample. Suitable elements include Na and Mg (1s and 2s); Zn, Ga, Ge and As (2p<sub>3/2</sub> and 3d); and Cd, In, Sn, Sb, Te, I, Cs and Ba (3p<sub>3/2</sub> and 4d or 3d<sub>5/2</sub> and 4d).

When the element is in a bulk homogeneous layer beneath a thin contaminating layer, the characteristic intensity ratio is modified in the opposite direction. Thus, for a pair of lines from subsurface species, the low kinetic energy line will be attenuated more than the high kinetic energy line, distorting the characteristic intensity ratio. By observing such intensity ratios and comparing them with the pure bulk elements, it is possible to deduce whether the observed lines are from predominantly surface-, subsurface- or homogeneously distributed material.

(3) Depth profiling can be accomplished using controlled erosion of the surface by ion sputtering. Table 5 lists some data on sputter rates as a general guide. One can use this technique on organic materials, but few data are available for calibration. Chemical states are often changed by the sputter technique, but useful information on elemental distribution can still be obtained.

*Table 5. Relative Sputter Rates at 4 kV.*

Target	Sputter Rate
Ta <sub>2</sub> O <sub>5</sub>	1.00
Si	0.90
SiO <sub>2</sub>	0.85
Pt	2.20
Cr	1.40
Al	0.95
Au	4.10

Another useful method of controlled erosion, especially of organic materials, is reaction with oxygen atoms from a plasma. This technique may also change the chemical states in the affected surface. Further, because the elements differ in their rates of reaction with oxygen atoms, the rate of removal of surface materials will be sample dependent.

(4) In XPS studies, the sample-mounting angle is not usually critical, though it does have some effect on the spectra. Very shallow electron take-off angles accentuate the spectrum of any component segregated on the surface, whereas a sample mounted at an angle normal to the analyzer axis minimizes the contribution from such a component. This effect can be used to estimate the depth of layers on or in the surface. This effect is not limited to flat surfaces, because angular dependence is even observed with powders, though the effects are muted. The spectrometer used to obtain the spectra presented in this handbook in-

tegrates the signal over only a narrow range of take-off angles.

It is possible to change the angle between the plane of the sample surface and the angle of entrance to the analyzer. At 90° with respect to the surface plane, the signal from the bulk is maximized relative to that from the surface layer. At small angles, the signal from the surface becomes greatly enhanced, relative to that from the bulk. The location of an element can thus be deduced by noting how the magnitude of its spectral peaks changes with sample orientation in relation to those from other elements. The analysis depth may be estimated by  $d = \lambda \sin\theta$ , where  $d$  is the analysis depth of the overlayer,  $\lambda$  is the inelastic mean free path, and  $\theta$  is the take-off angle of the analyzed electrons.

Perkin-Elmer SCAs permit angle-dependent studies by simply varying the angle of the sample surface with respect to the input lens of the analyzer. The magnification of the lens determines the half-angle acceptance of the analyzer. An example of the information that can be gained through the use of this capability is shown in Figure 14. Data were obtained at normal (near 90°) and grazing (near 15°) take-off angles from a silicon sample with a thin silicon oxide overlayer. The observed intensity ratio of oxidized to elemental Si is much greater at the low take-off angle.

**b. Surface Distribution.** Many current XPS systems have the capability to obtain data from areas as small as 30  $\mu\text{m}$  in diameter. This relatively high lateral resolution allows for the acquisition of XPS maps which show both elemental and chemical state information.

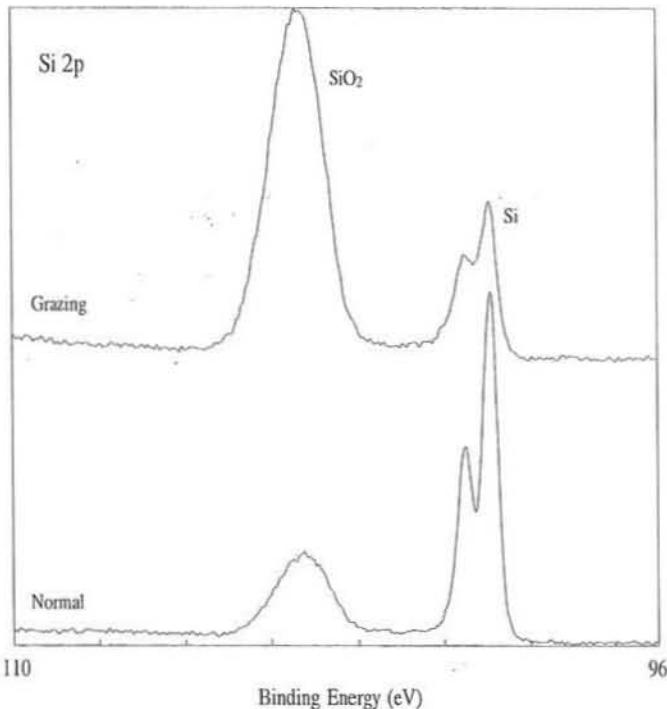


Figure 14. An example of the enhanced surface sensitivity achieved by varying the electron take-off angle. A thin oxide on silicon is enhanced at the low take-off angle.

**c. Insulating Domains on a Conductor.** The occurrence of steady-state charging of an insulator during analysis sometimes has useful consequences. Microscopic insulating domains on a conductor reach their own steady-state charge, while the conductor remains at spectrometer potential. Thus, an element in the same chemical state in both phases will exhibit two peaks. If a change is made in the supply of low-energy electrons which stabilize the charge (as from the neutralizer filament) or if a bias is applied to the conductor, the spectral peaks from the insulating phase will move relative to those from the conducting phase. For such heterogeneous systems, this can be an extremely useful technique. It makes it possible to determine whether the elements that contribute to the overall spectrum are in the conducting phase, the insulating phase or both.

## F. How to Use this Handbook

### 1. Qualitative Analysis

Elemental and chemical identification of sample constituents can be performed by combining the information in the survey spectra with the binding energy tables of Appendices G, H and J.

- a. Identify all major photoelectron peaks by using the line position tables in Appendix J.
- b. Compare the elemental identifications with the elemental survey spectra to see that line positions and relative intensities are consistent. Also note the positions of the Auger electron peaks.
- c. Review Section E (pp. 16-28) to account for fine structures such as energy loss lines, shake-up peaks, satellite lines, etc., not identified in the handbook spectra or energy tables.
- d. Identify any remaining peaks assuming they are intense photoelectron or Auger lines using Appendices G or H.
- e. Chemical state identification can be determined from high resolution spectra of the strongest photoelectron and sharpest Auger lines.
  - (1) Correct binding energies for static charging of insulators. When applicable, charge reference the binding energy scale to the C 1s photoelectron peak at 284.8 eV.
  - (2) Determine the chemical state from the measured shifts in the photoelectron binding ener-

gies by comparing the binding energy to the charts with the standard spectra and with the tabulated data in Appendix B.

(3) As suggested above, much about the chemical state can be learned from the magnitude and position of shake-up lines as well as from the energy and shape of valence Auger lines.

(4) For the elements F, Na, Al, Si, S, Cu, Zn, As, Se, Ag, Cd, In, Sn and Te, the Auger parameter tables in Appendix A may prove useful. The Auger line positions may be converted to kinetic energy by subtracting from the photon energy (Al = 1486.6 eV, Mg = 1253.6 eV). Note the location of the points for Auger kinetic energy and photoelectron binding energy on the respective elemental plot. Proximity of the experimental points to those of recorded chemical states should be considered probable identification. Note that experimental error is much greater along the Auger parameter grid than normal to the grid lines.

### 2. Quantification

The atomic sensitivity factors presented in Appendices E and F are applicable to the Perkin-Elmer Model 10-360 SCA and the Omni Focus III lens. A simplified expression to determine the atomic concentration of any element is given by Equation 8 (p. 25). However, the accuracy is limited by the assumptions made in Section E.4. (p. 25).



## **II. Standard XPS Spectra of the Elements**



# Standard Spectra of the Elements

This section of the handbook contains survey spectra of 81 elements, high resolution spectra of the most useful photoelectron lines, a chart of binding energies for each of the observed photoelectron and major Auger electron peaks, and a photoelectron chemical state binding energy chart for each of the elements. Used in combination with the appendices, the survey spectra aid in elemental identification, while the high-resolution spectra and binding energy data aid in the identification of chemical states.

## Survey Spectra

The survey data include all of the lines which are normally useful. For most elements, the survey data were acquired with both a monochromatic Al x-ray source and a nonmonochromatic Mg x-ray source. When survey spectra for two compounds are presented, the monochromatic source is used for both. The photon source for each survey is noted on the survey. The photoelectron and Auger lines for the element of interest are identified. Lines which occur due to other

elements are only designated by the elemental symbol, and x-ray satellites and energy loss lines are not noted. For many elements, the Auger peaks are presented in expanded form.

The ordinate is left undesignated, but the general contours and intensity ratios of the spectra are typical of measurements made using a Perkin-Elmer Model 10-360 SCA with an Omni Focus lens.

## High-Resolution Spectra

The high-resolution spectra of the most useful photoelectron peaks are presented. Unless otherwise noted, the high-resolution data were acquired using the same photon source as the survey on the same page. The binding energy of the main line is noted and when appropriate, the spin orbit separation ( $\Delta$ ) is given. The lines from insulators were charge-corrected to adventitious hydrocarbon at 284.8 eV.

The spectra of the inert gas atoms implanted in graphite or silicon deserve special mention. The high-resolution data often show an asymmetric peak shape or a second resolvable peak when a single symmetric peak is expected. The intensity of the second, high binding energy peak is dependent on the implantation energy and is diminished at lower energies. The spectra are of inert gas atoms implanted at 4 kV.

## Photoelectron and Auger Electron Line Position Tables

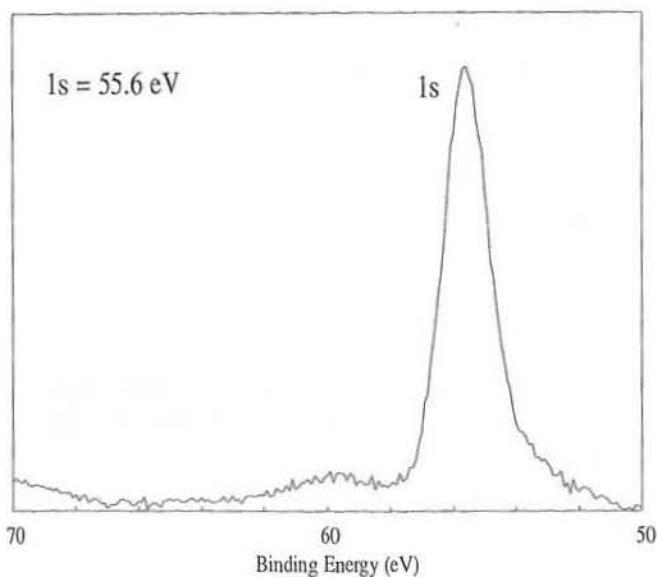
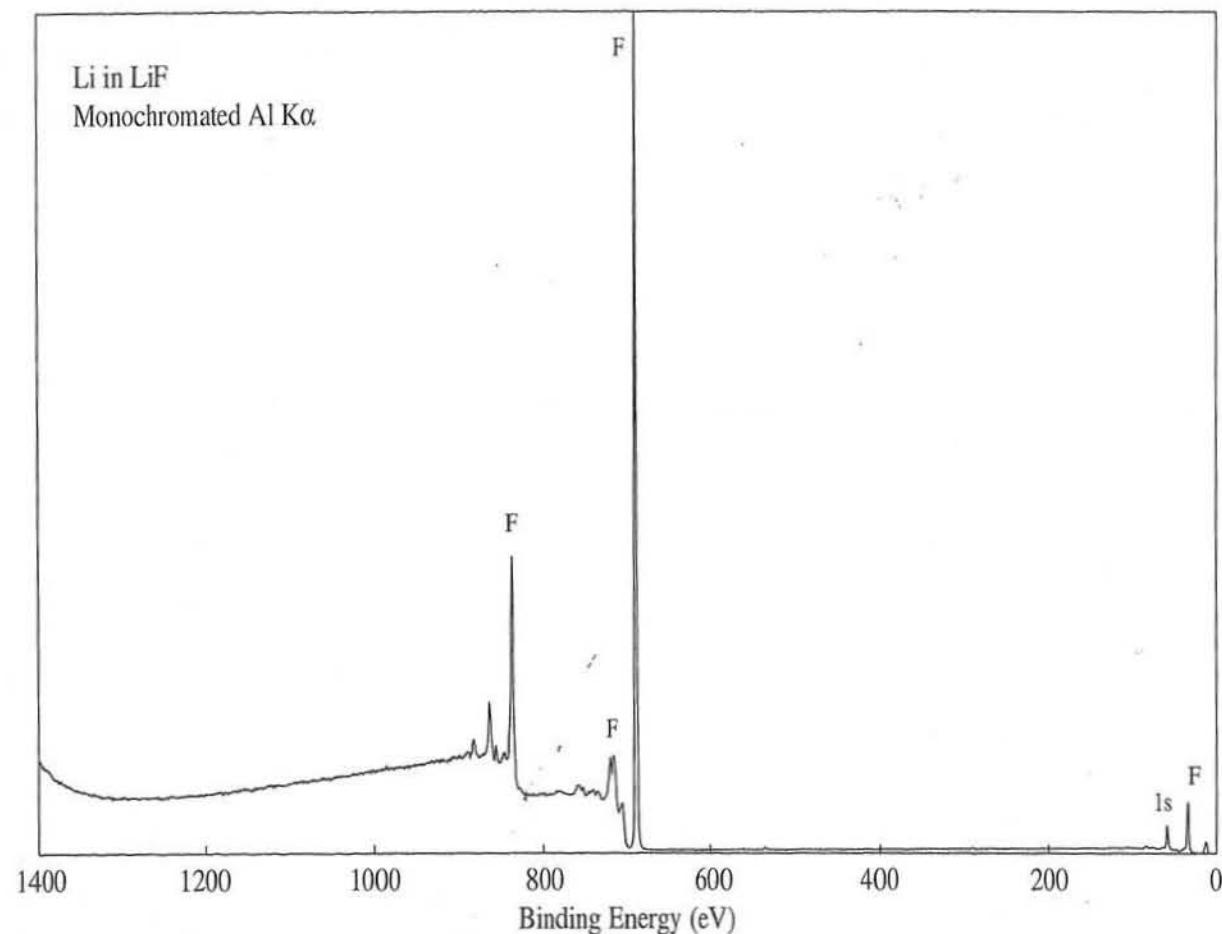
The photoelectron and Auger line position tables reflect the energies of the elemental peaks observed in this handbook. For oxidized or

reduced species, the measured values may differ by a few electron volts.

## Chemical State Binding Energy Tables

The binding energy tables have been constructed to reflect the general changes in binding energy with change in oxidation state or chemical environment. A more extensive listing with specific binding energy values for more than 1500 compounds is presented in Appendix B.

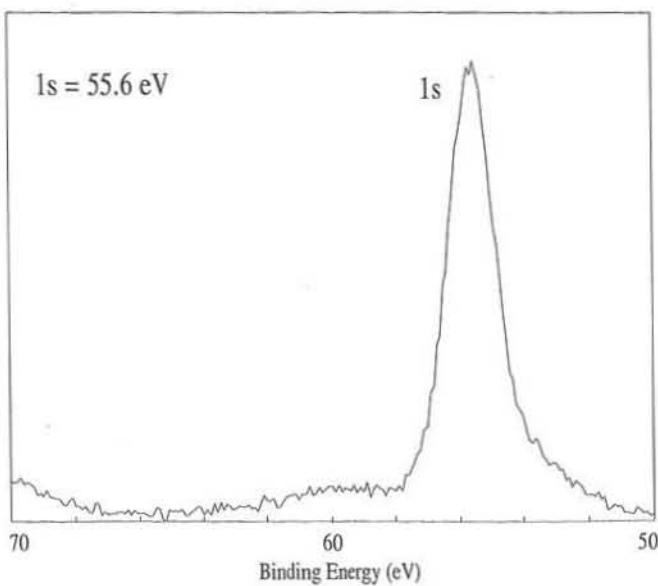
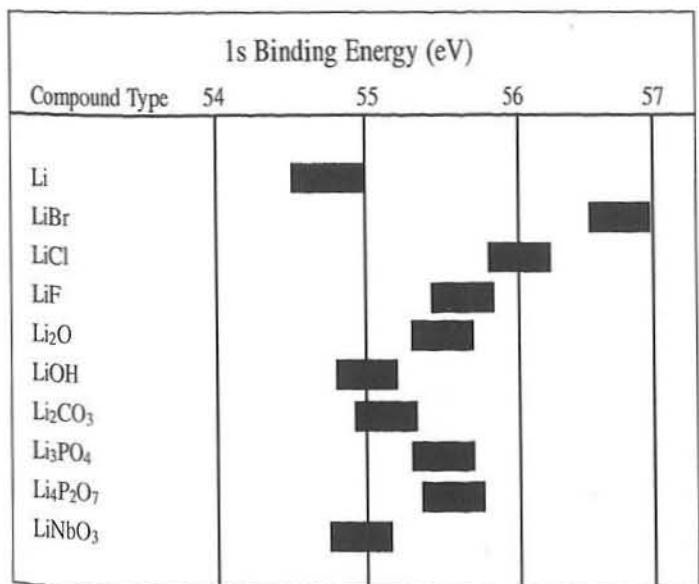
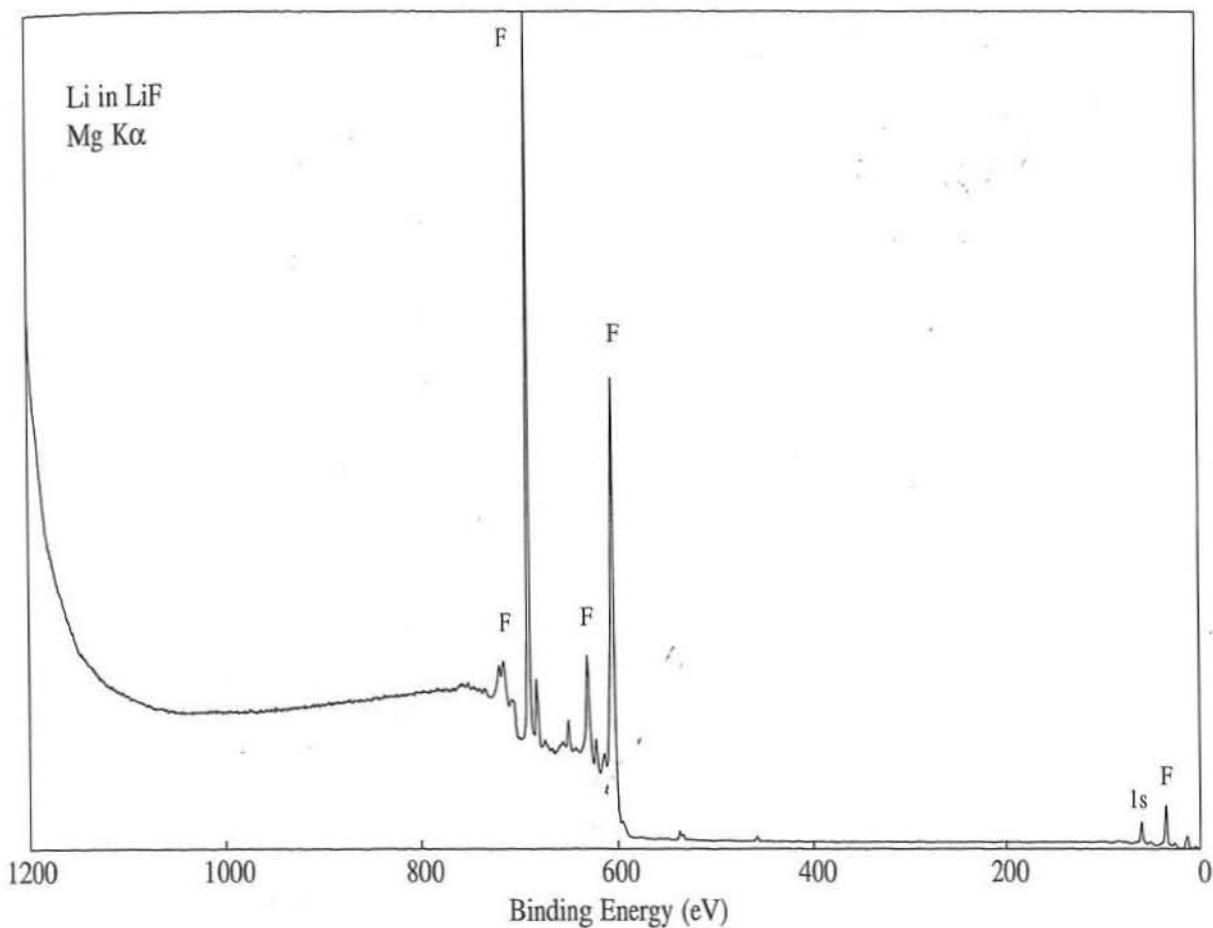
Abbreviations in the chemical state database are as follows: acac = acetyl acetonate; metallocene = metal  $(C_5H_5)_2$ ; Bu = butyl; Et = ethyl; Me = methyl; Ph = phenyl; OAc = acetate.

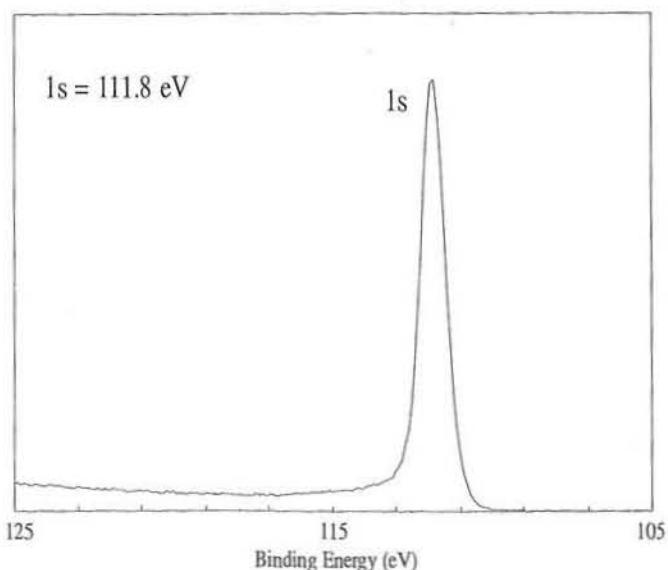
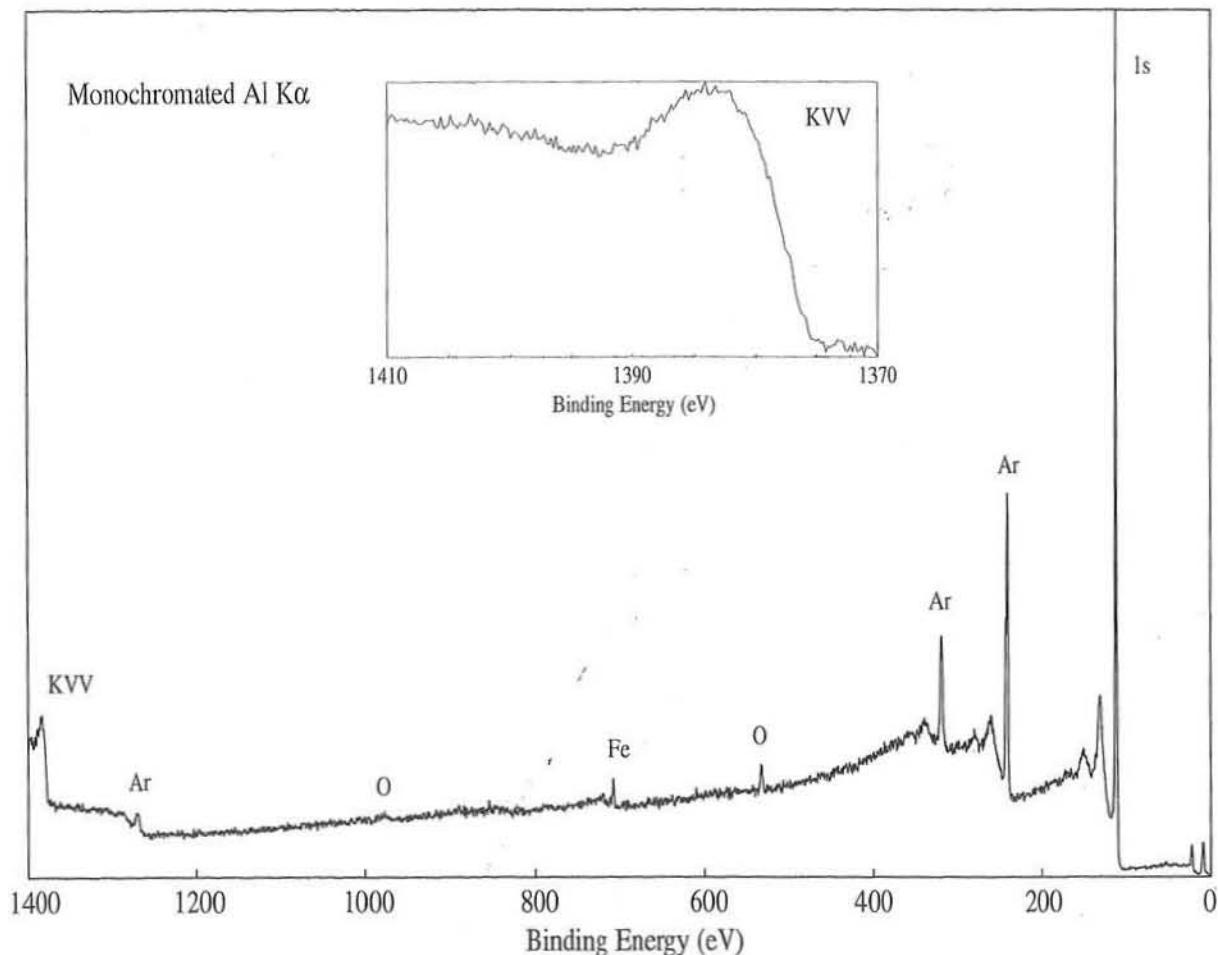


Line Positions (eV)

Photoelectron Lines

1s	56
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Line Positions (eV)

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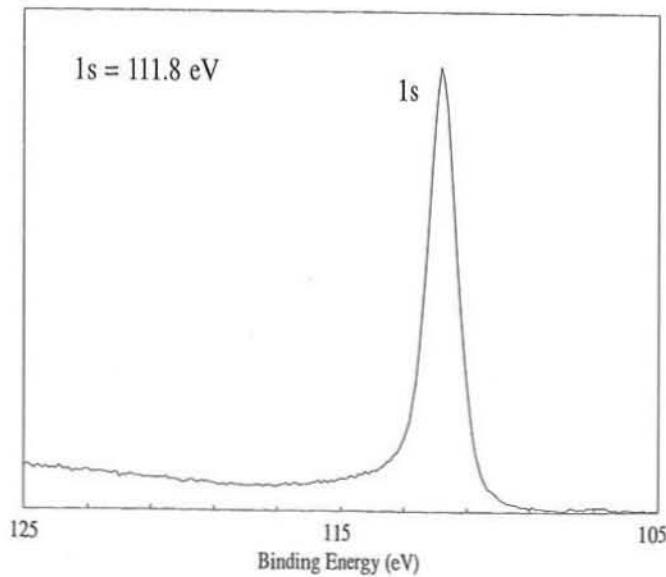
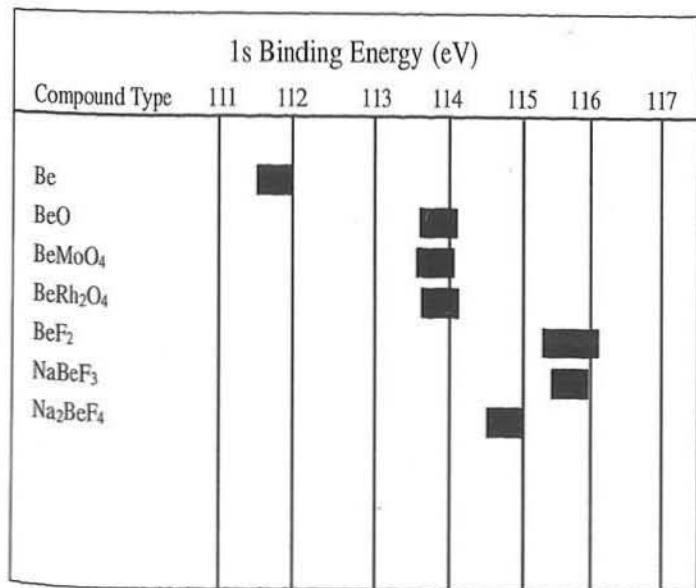
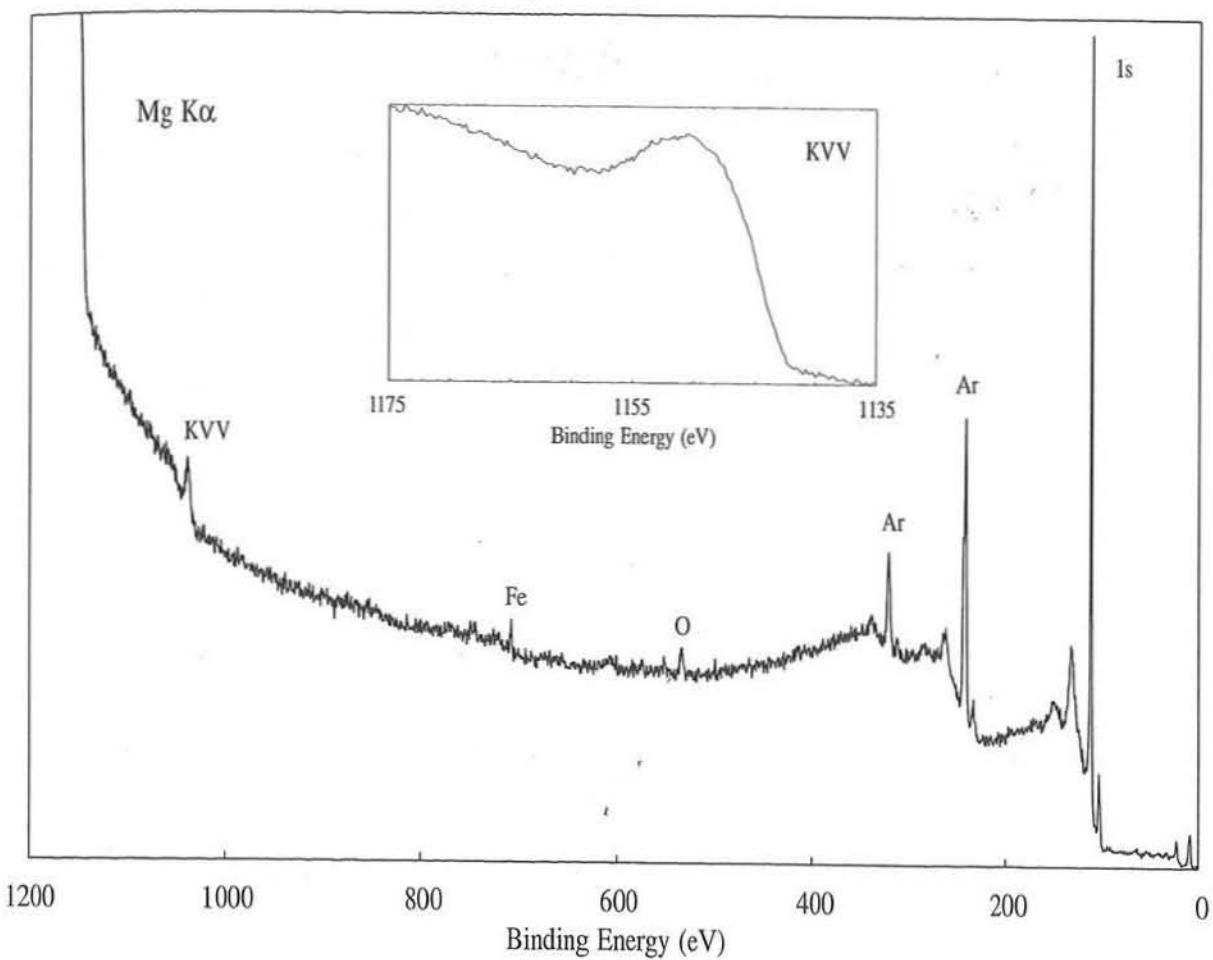
Photoelectron Lines

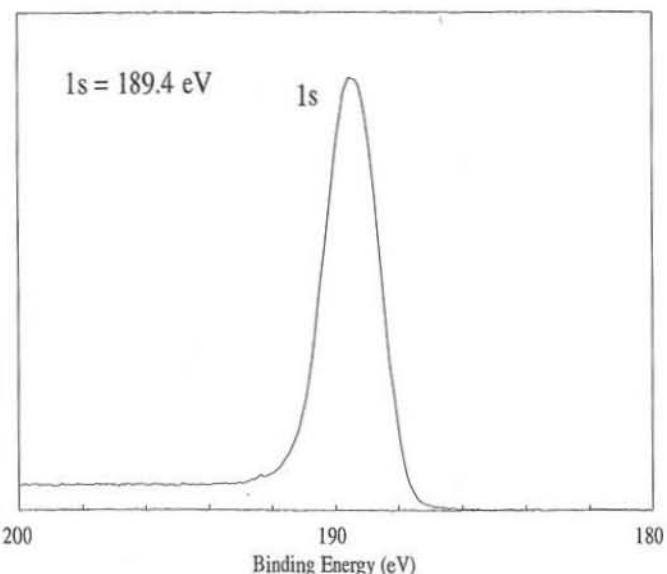
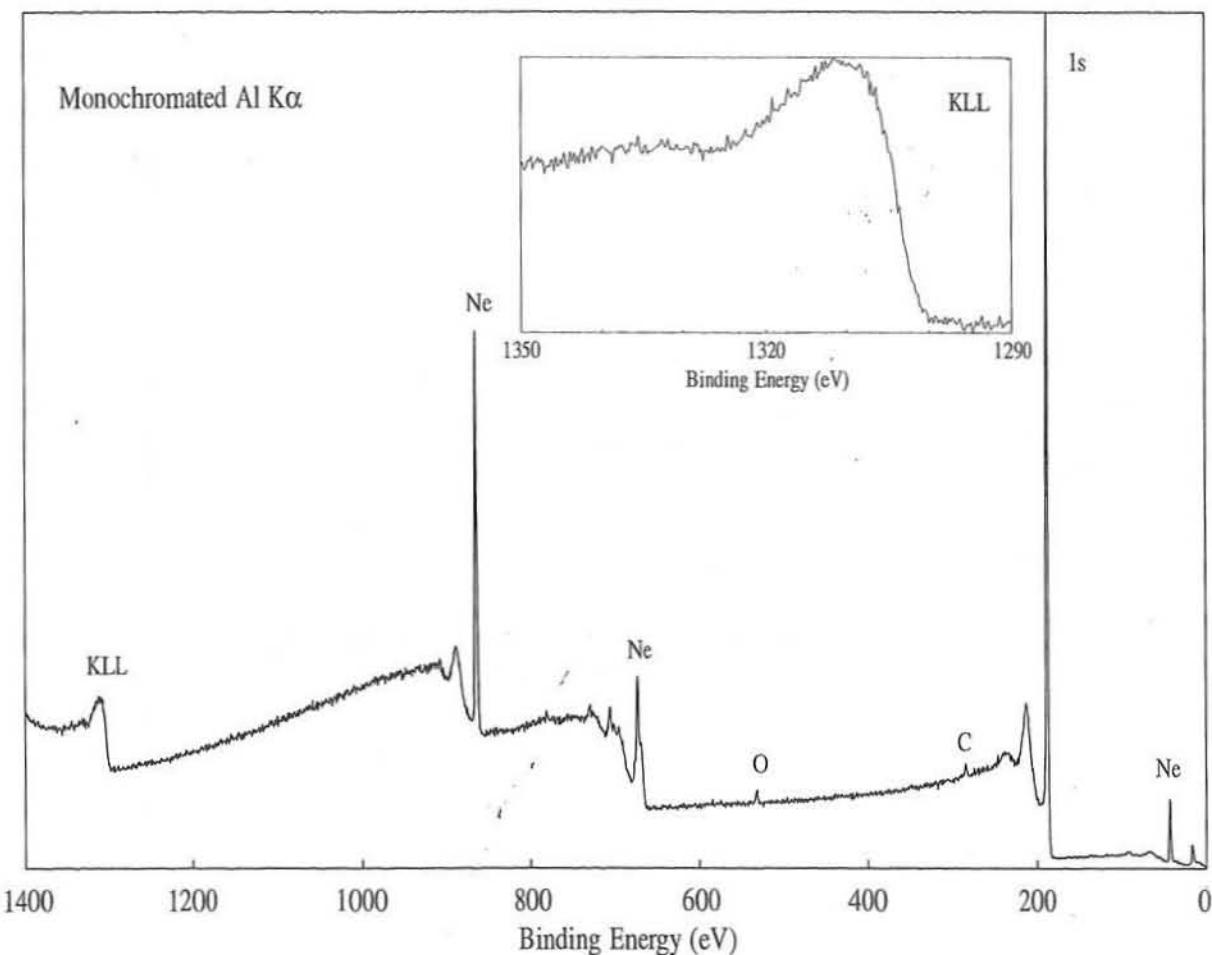
1s	112
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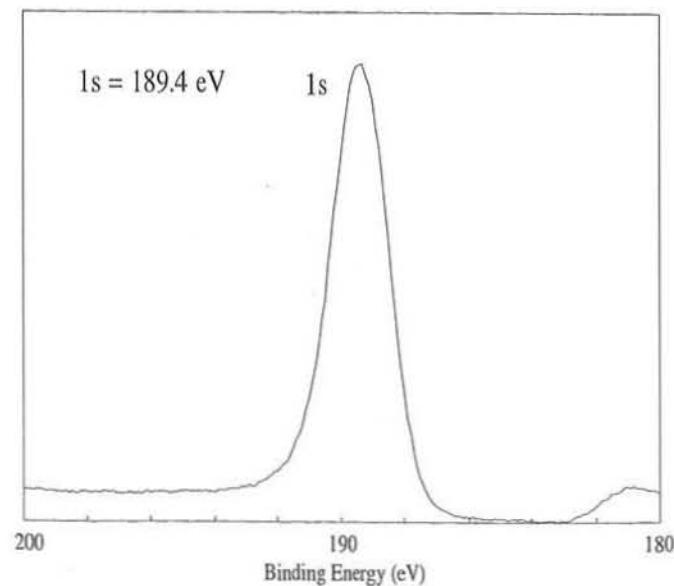
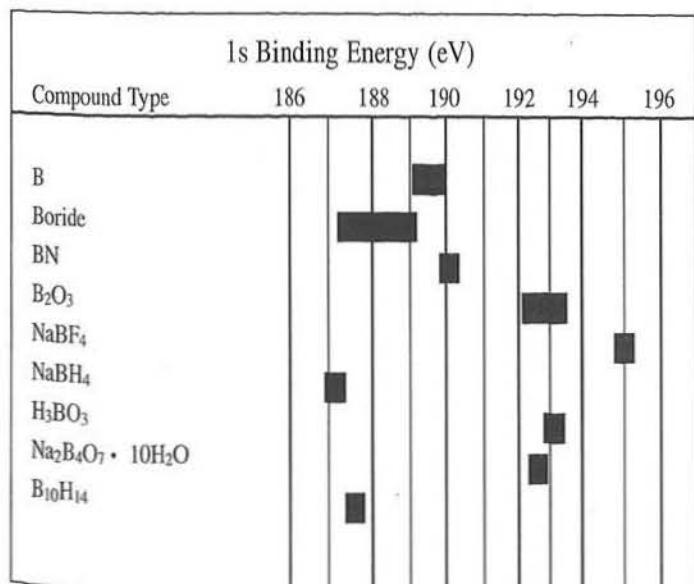
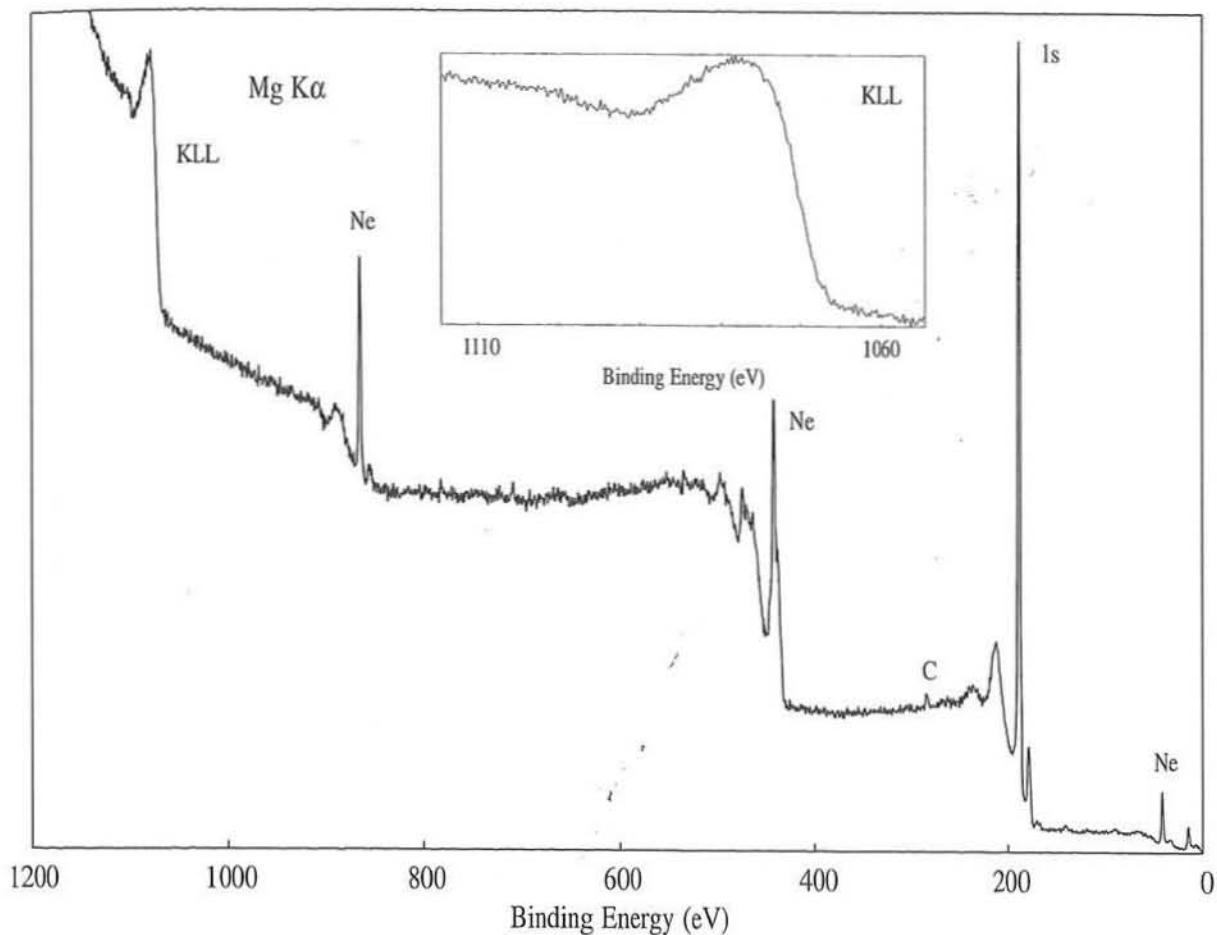
Auger Lines

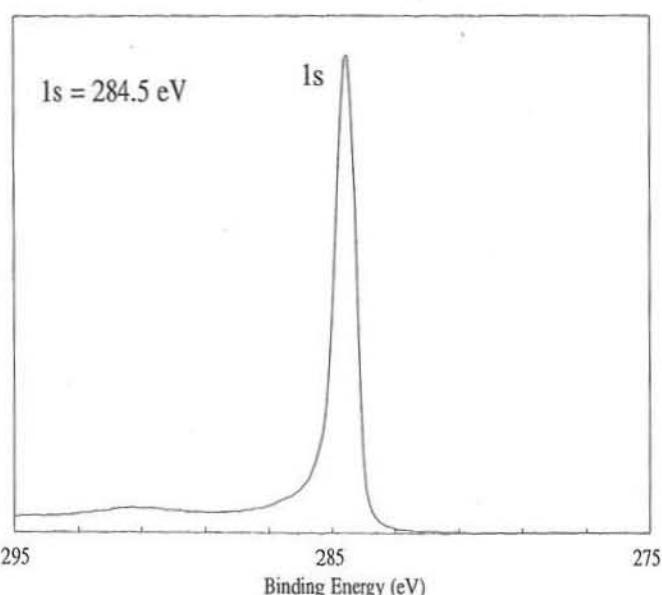
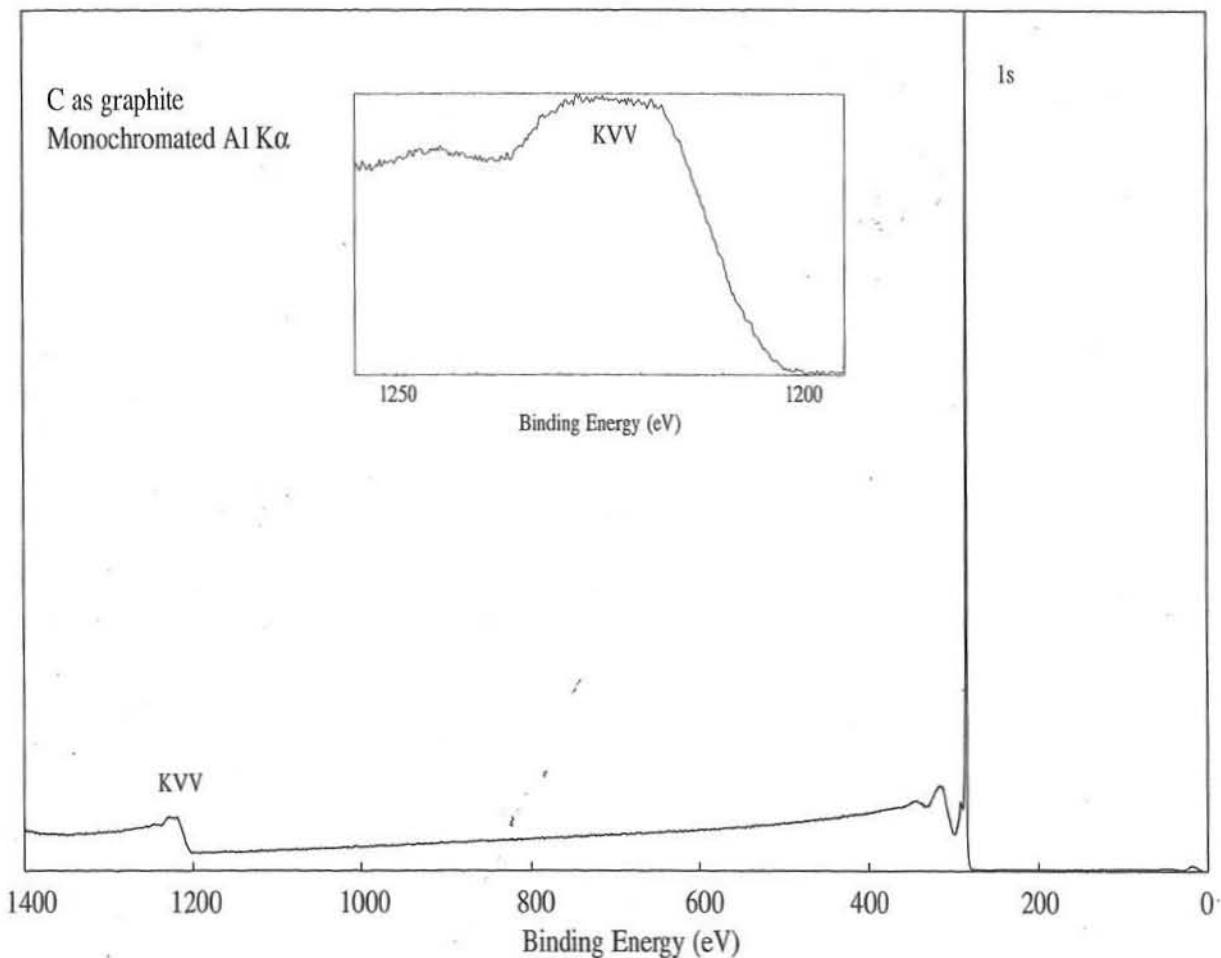
KVV	
1384	(Al)
1151	(Mg)





Line Positions (eV)	
<u>Photoelectron Lines</u>	
1s	189
<u>Auger Lines</u>	
KLL	
1310	(Al)
1077	(Mg)





Line Positions (eV)

Photoelectron Lines

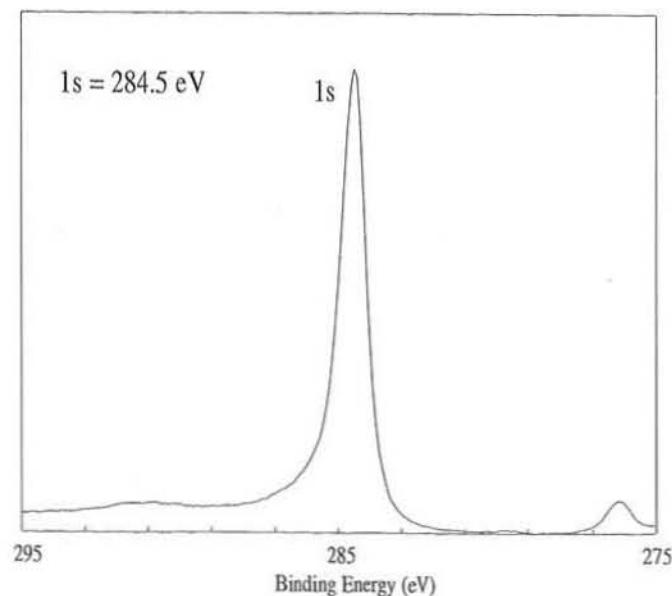
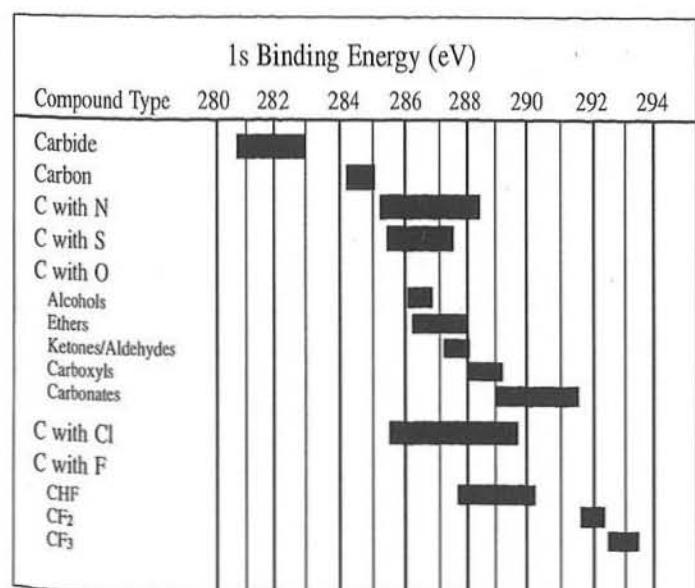
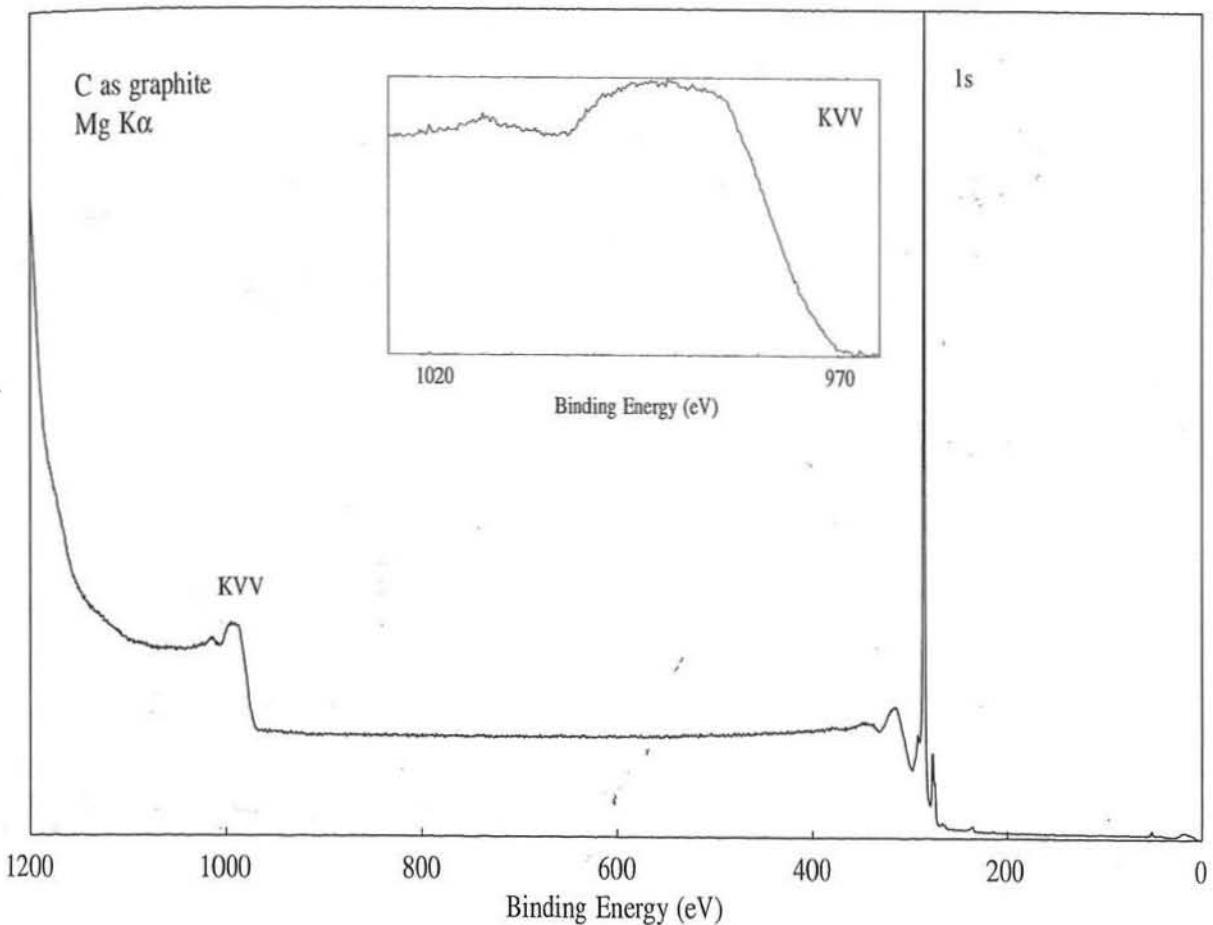
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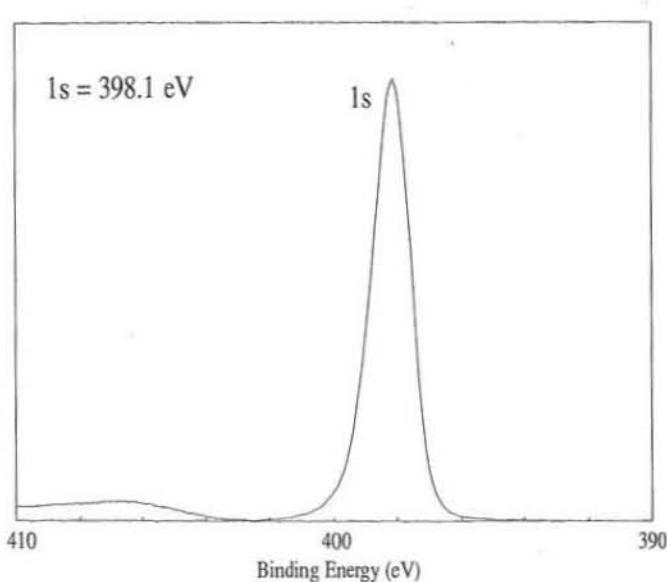
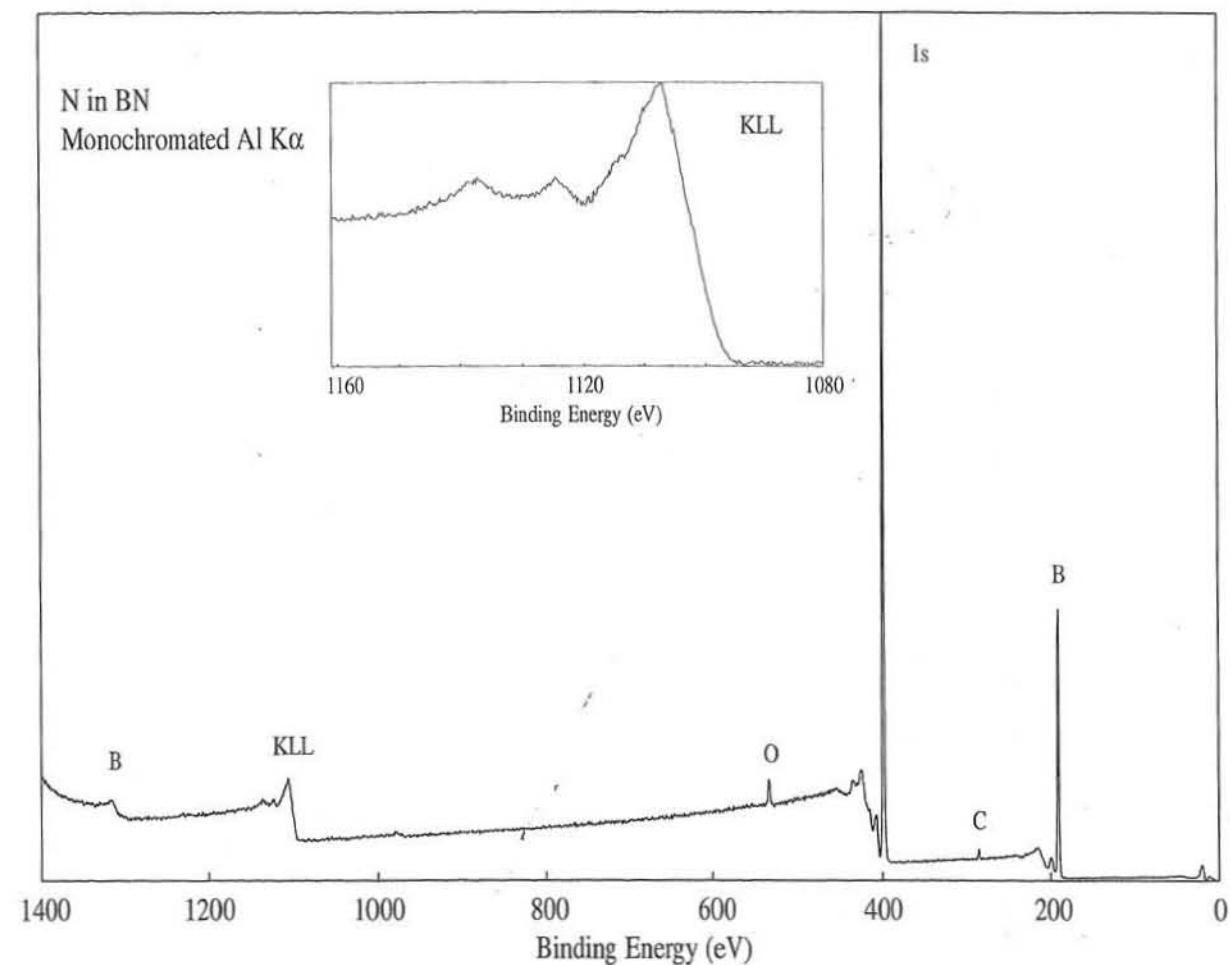
1s                          285

Auger Lines

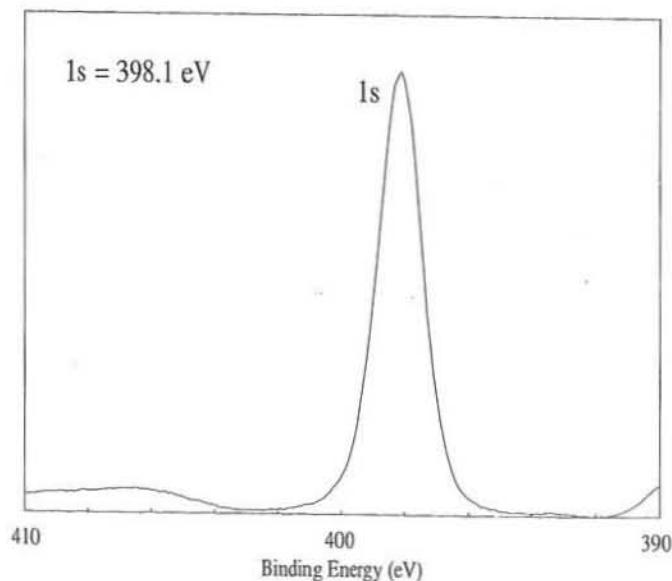
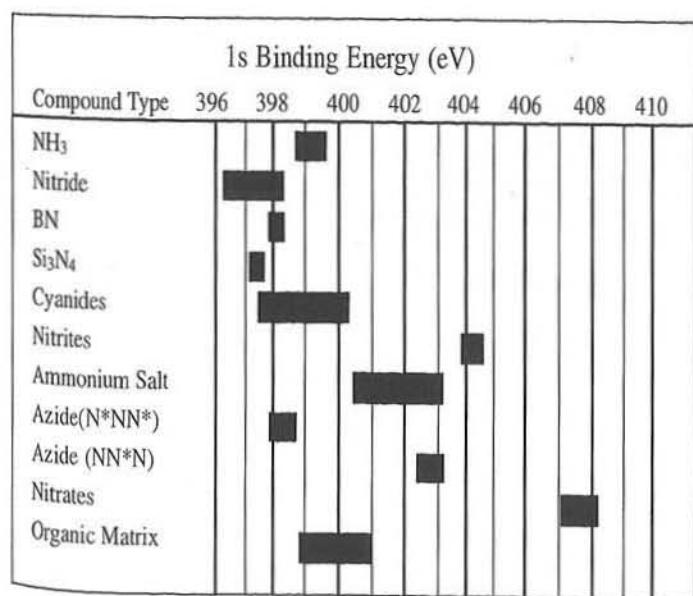
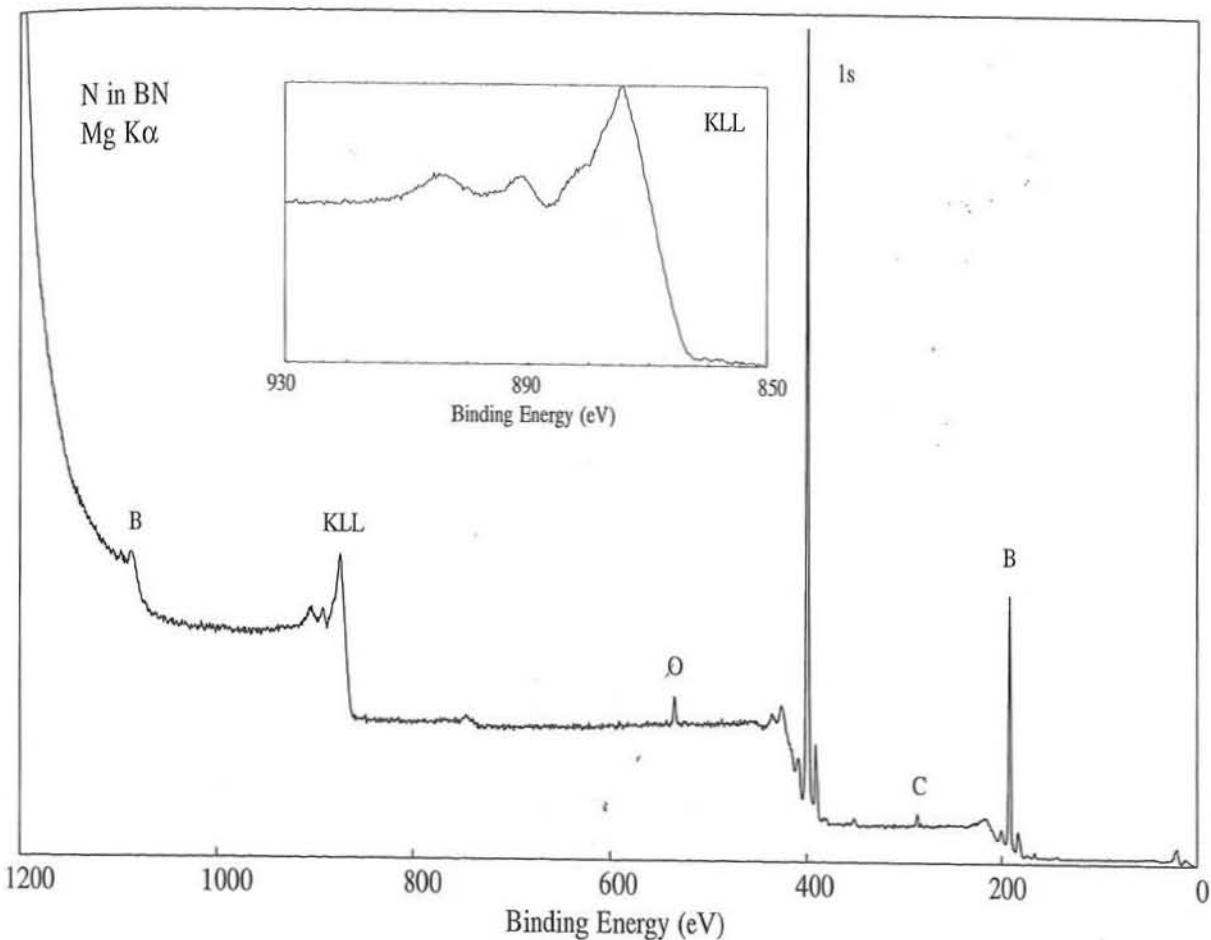
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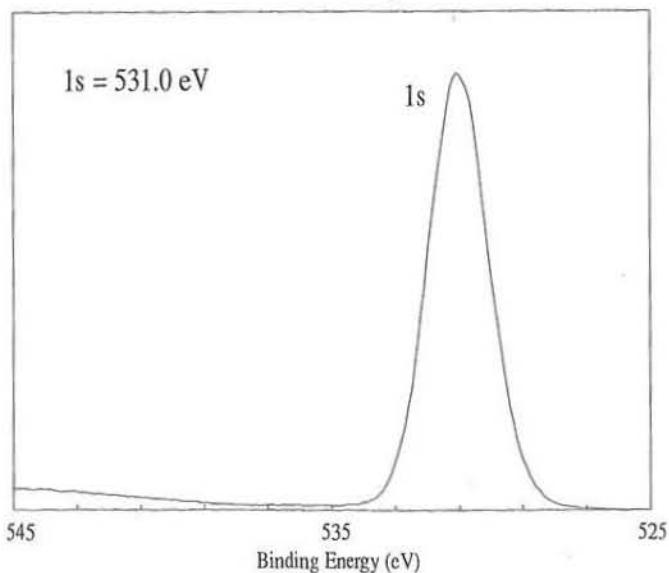
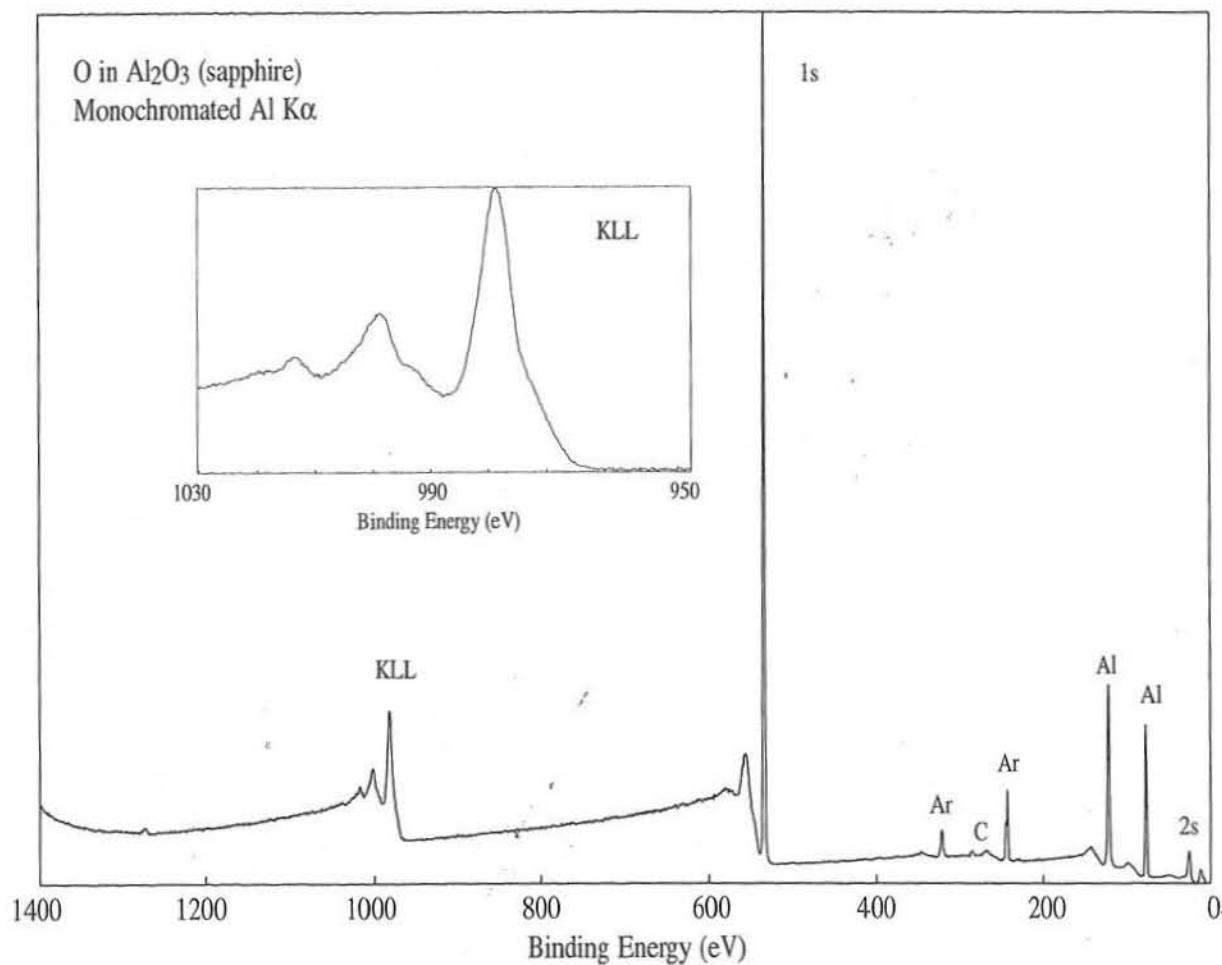
KVV                          1223                          (Al)  
990                          (Mg)



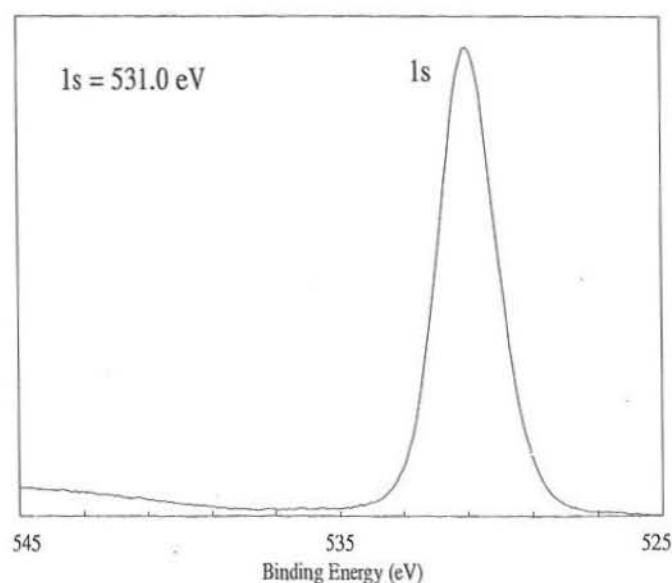
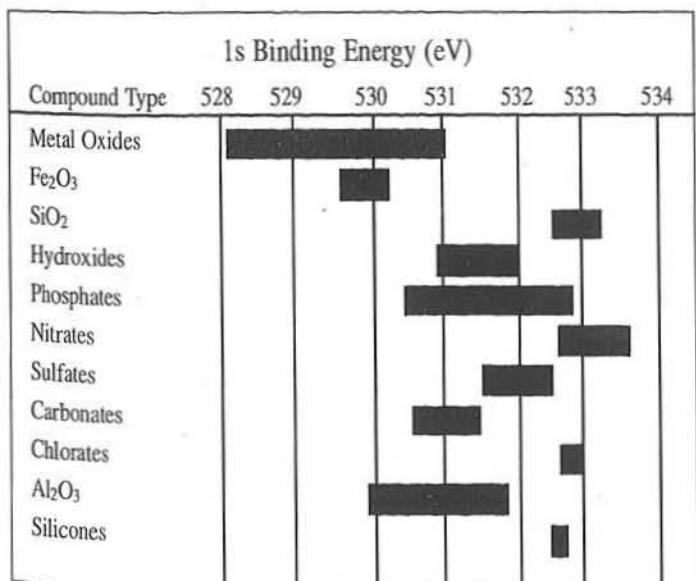
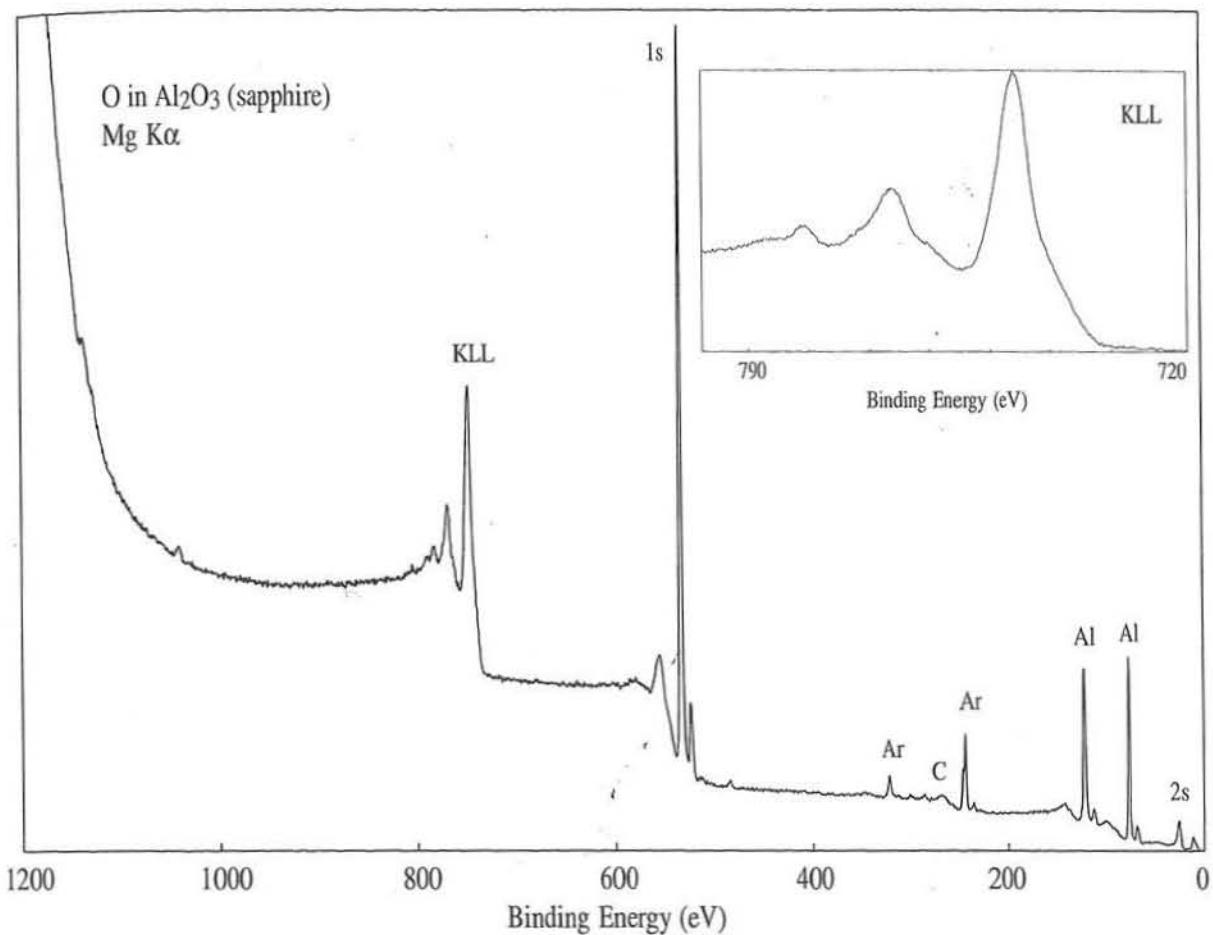


Line Positions (eV)	
<u>Photoelectron Lines</u>	
1s	398
<u>Auger Lines</u>	
KLL	
1107	(Al)
874	(Mg)



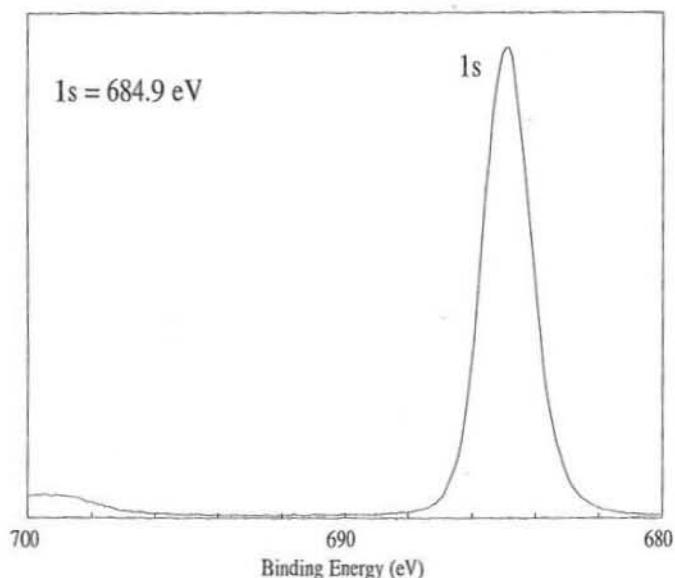
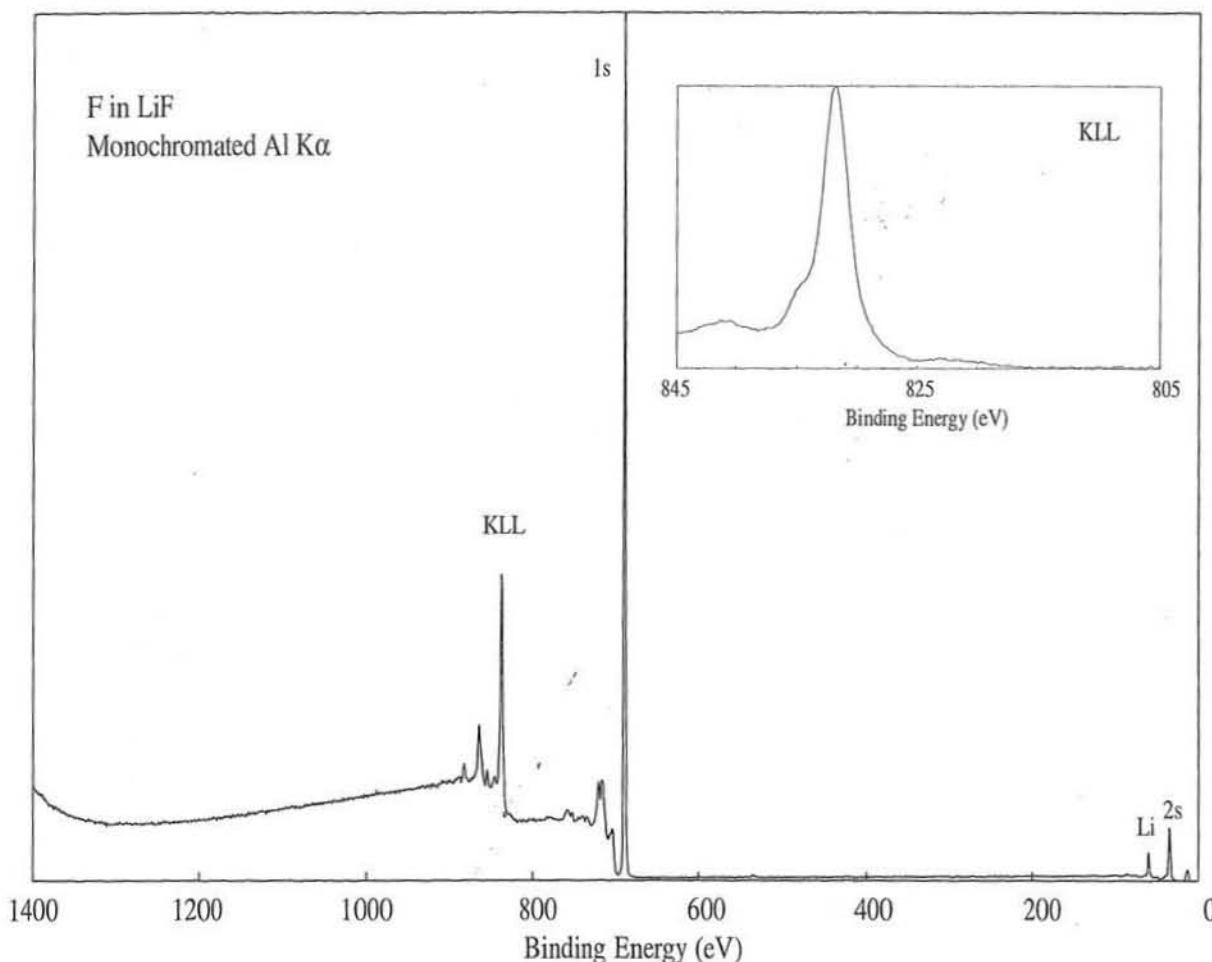


Line Positions (eV)			
<u>Photoelectron Lines</u>			
1s	2s		
531	23		
<u>Auger Lines</u>			
KL <sub>1</sub> L <sub>1</sub>	KL <sub>1</sub> L <sub>23</sub>	KL <sub>23</sub> L <sub>23</sub>	
1013	999	978	(Al)
780	766	745	(Mg)



Fluorine F  
Atomic Number 9

## Handbook of X-ray Photoelectron Spectroscopy



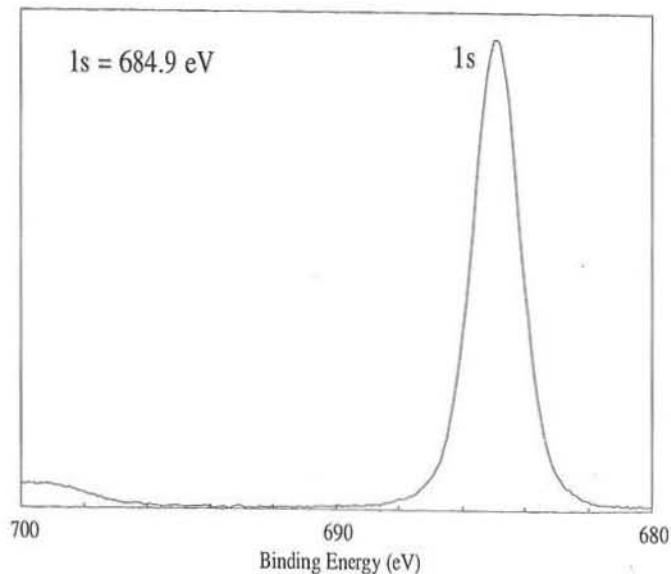
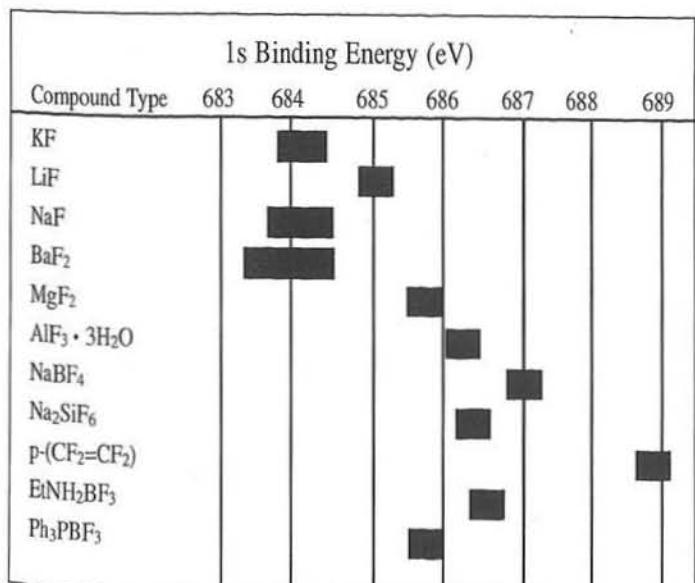
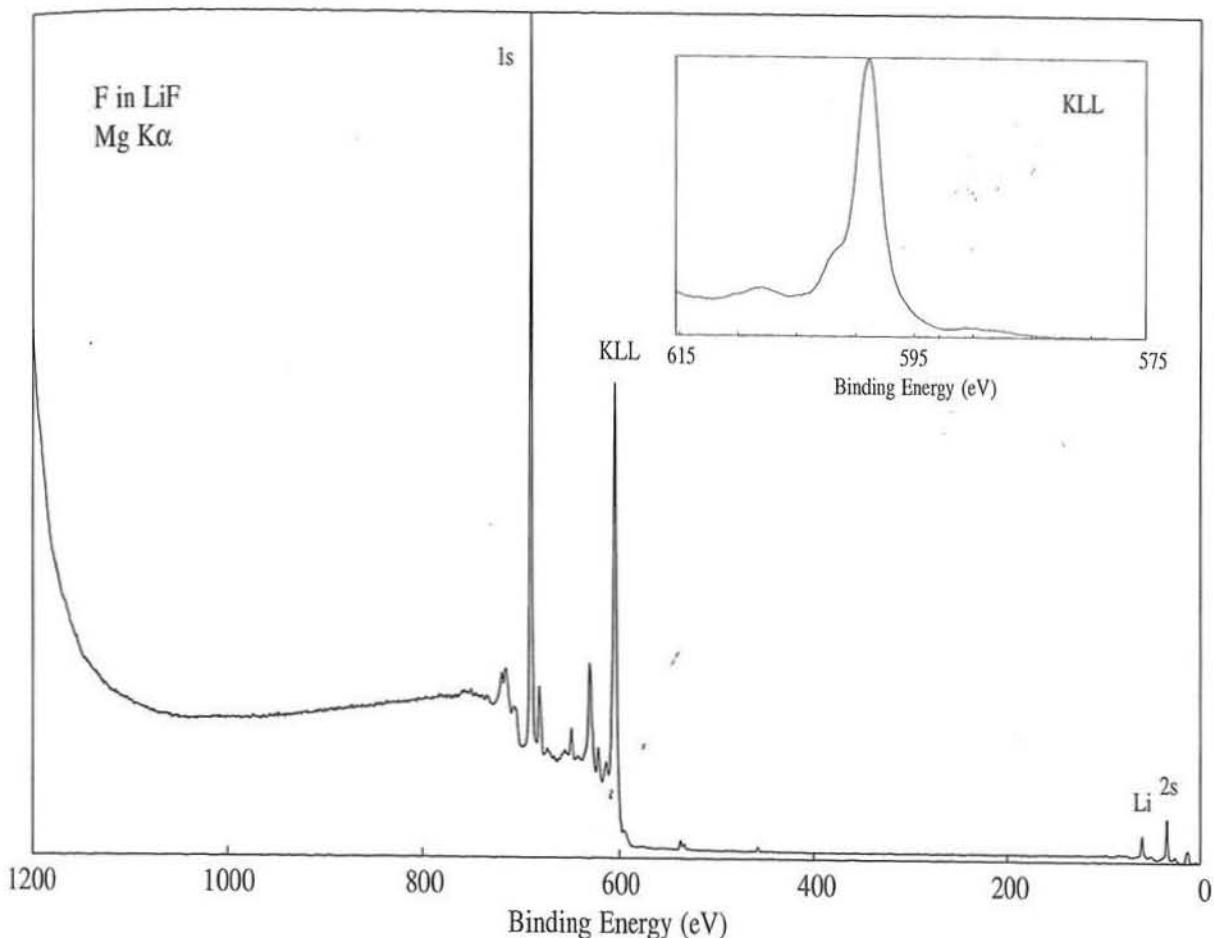
Line Positions (eV)

Photoelectron Lines

1s	2s
685	30

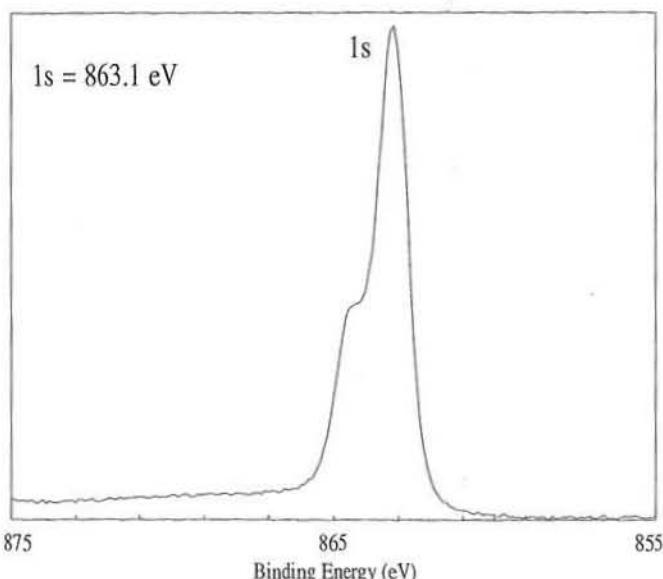
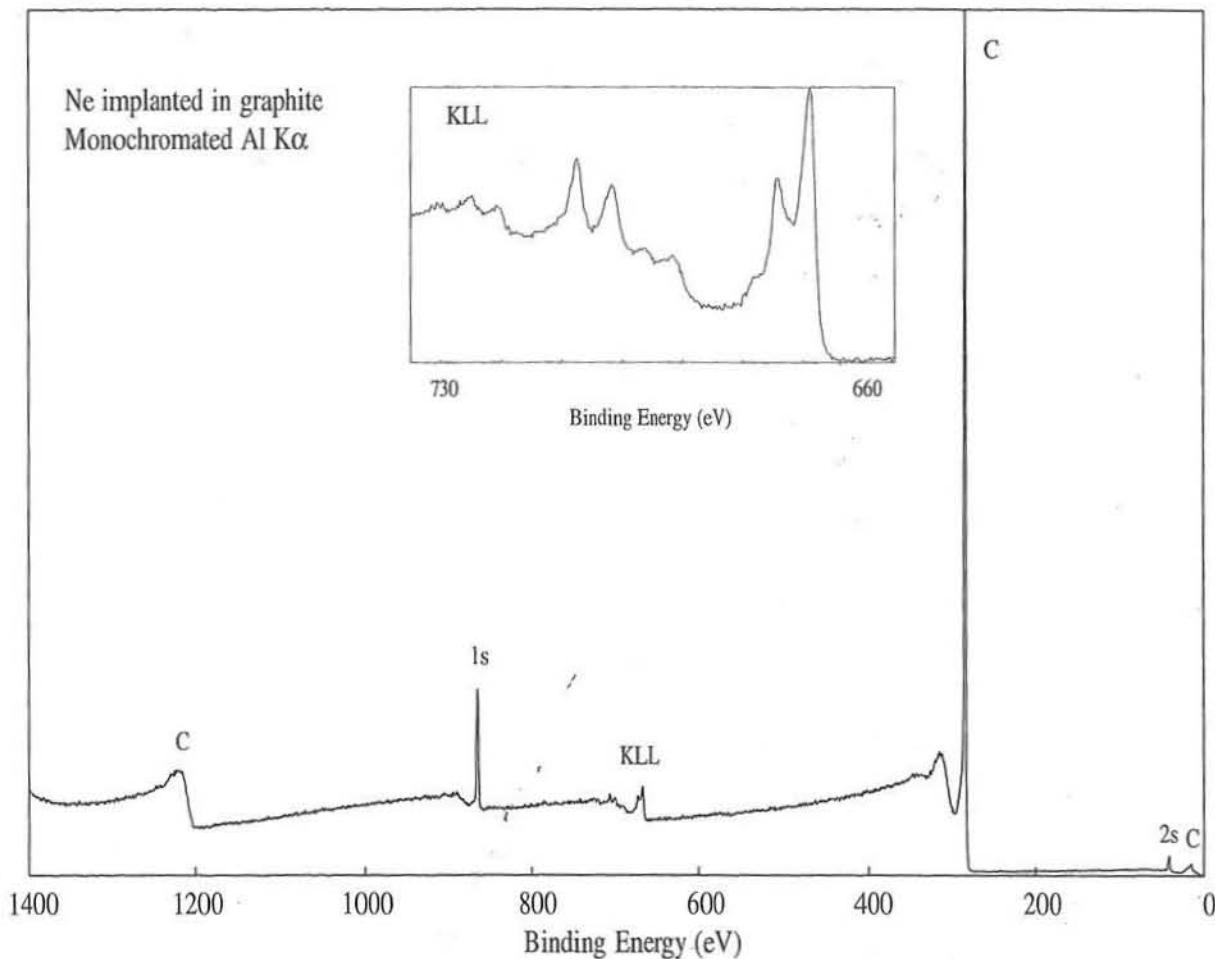
Auger Lines

KL <sub>1</sub> L <sub>1</sub>	KL <sub>1</sub> L <sub>23</sub>	KL <sub>23</sub> L <sub>23</sub>
877	858	832 (Al)
644	625	599 (Mg)

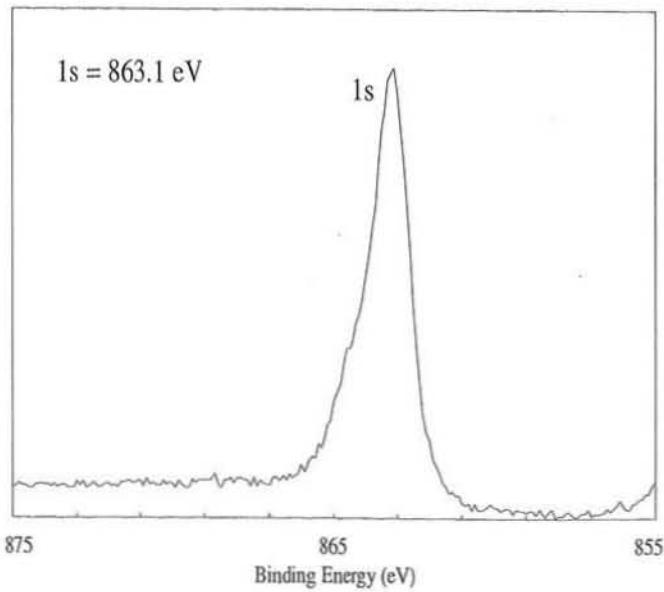
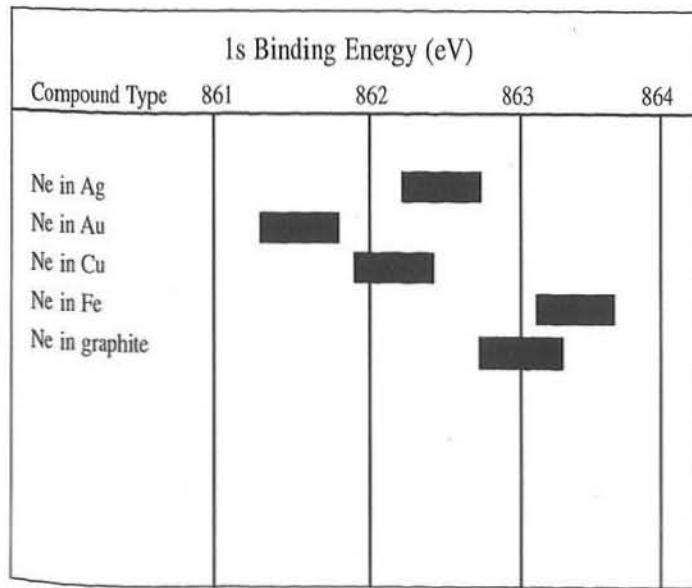
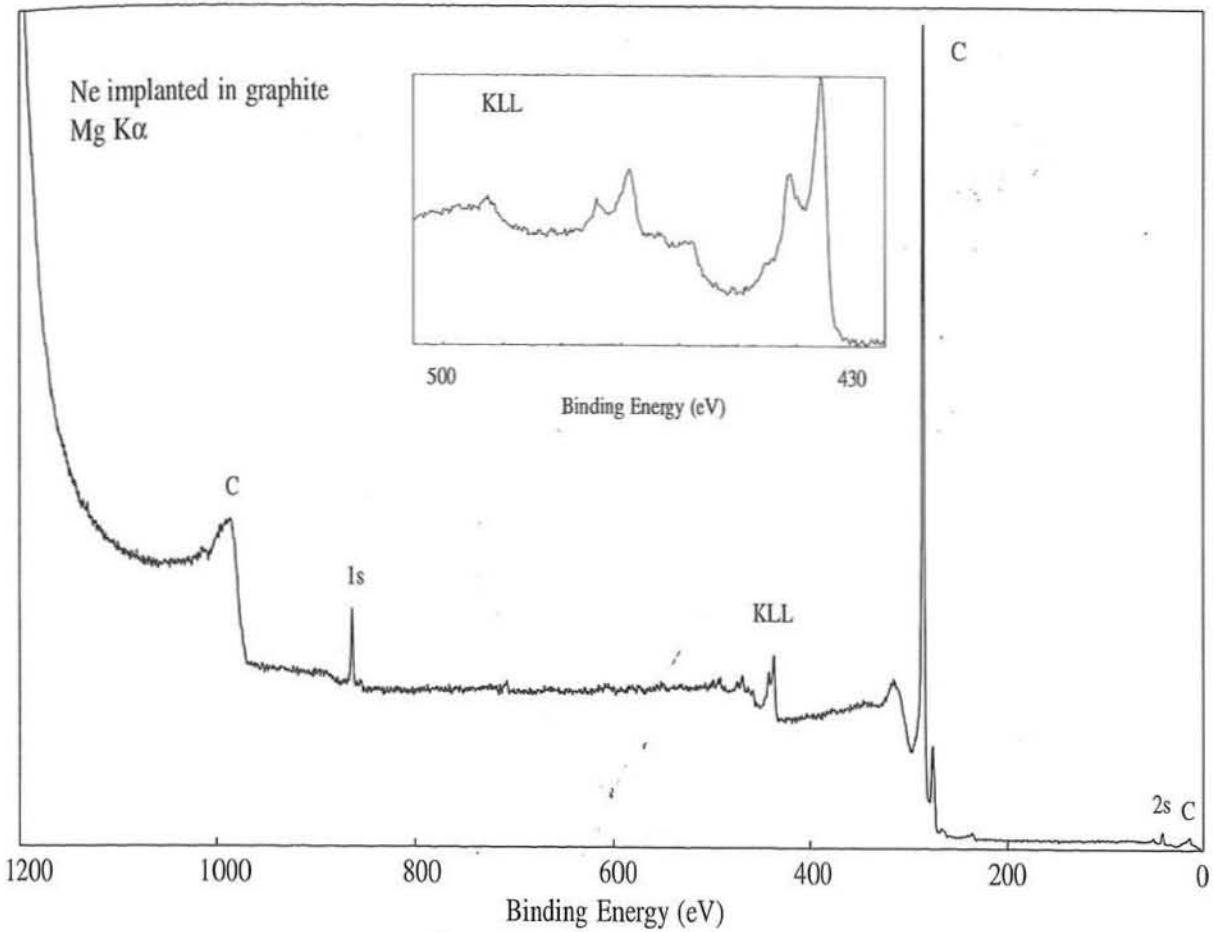


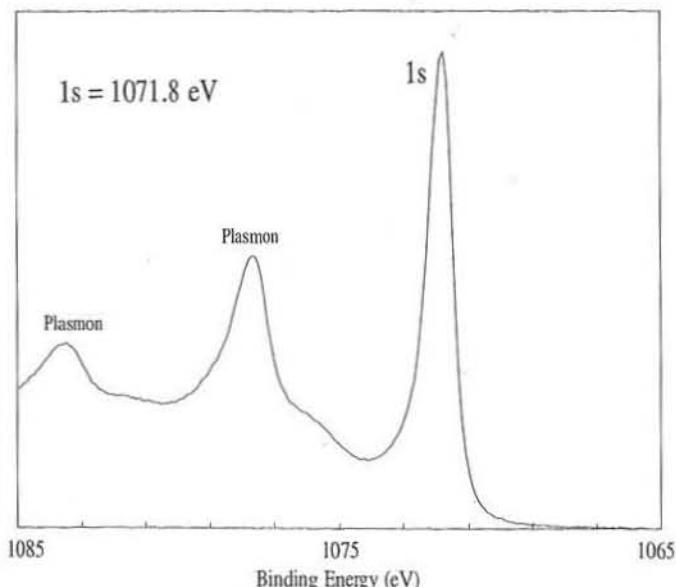
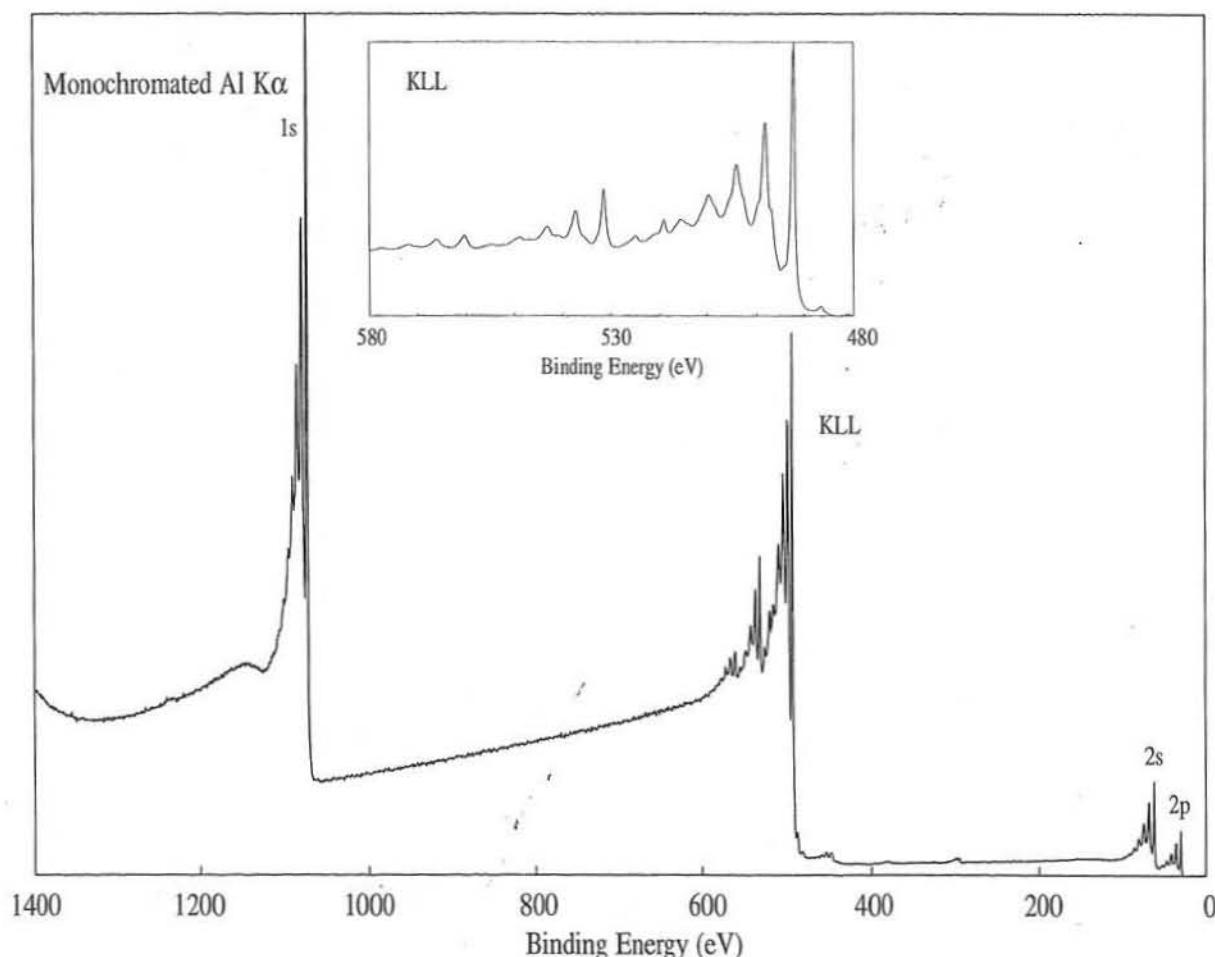
**Neon**      Ne  
Atomic Number 10

# Handbook of X-ray Photoelectron Spectroscopy



Line Positions (eV)		
<u>Photoelectron Lines</u>		
1s	2s	2p
863	41	14
<u>Auger Lines</u>		
KL <sub>1</sub> L <sub>1</sub>	KL <sub>1</sub> L <sub>23</sub>	KL <sub>23</sub> L <sub>23</sub>
725	702	669 (Al)
492	469	436 (Mg)





Line Positions (eV)

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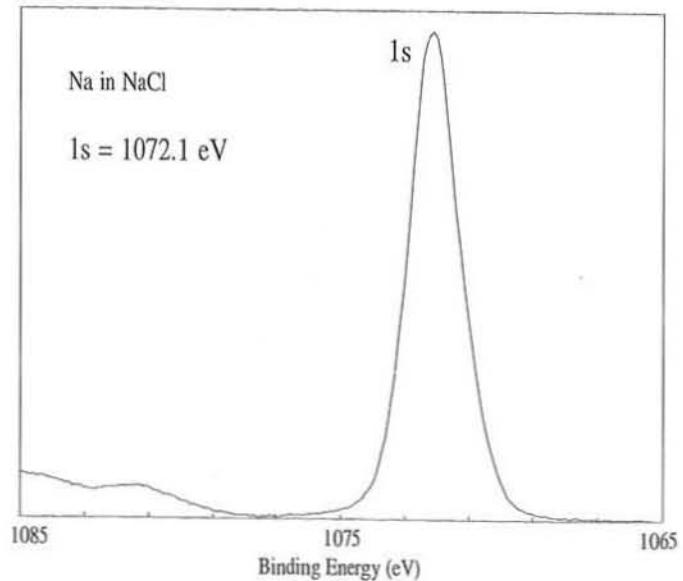
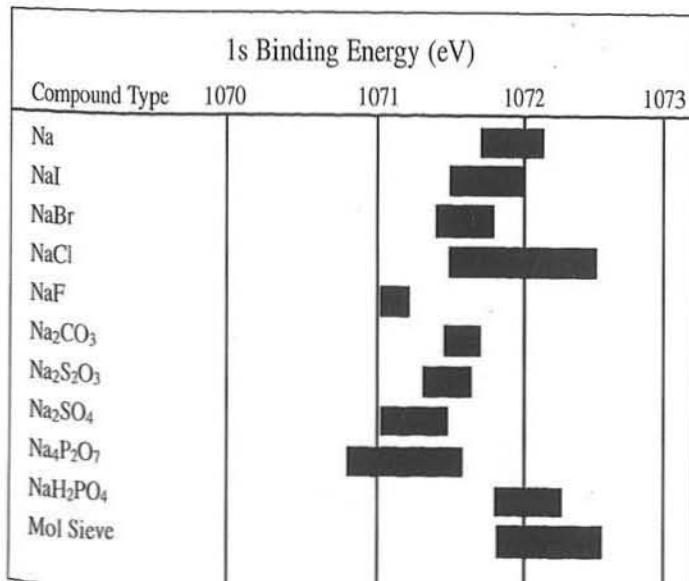
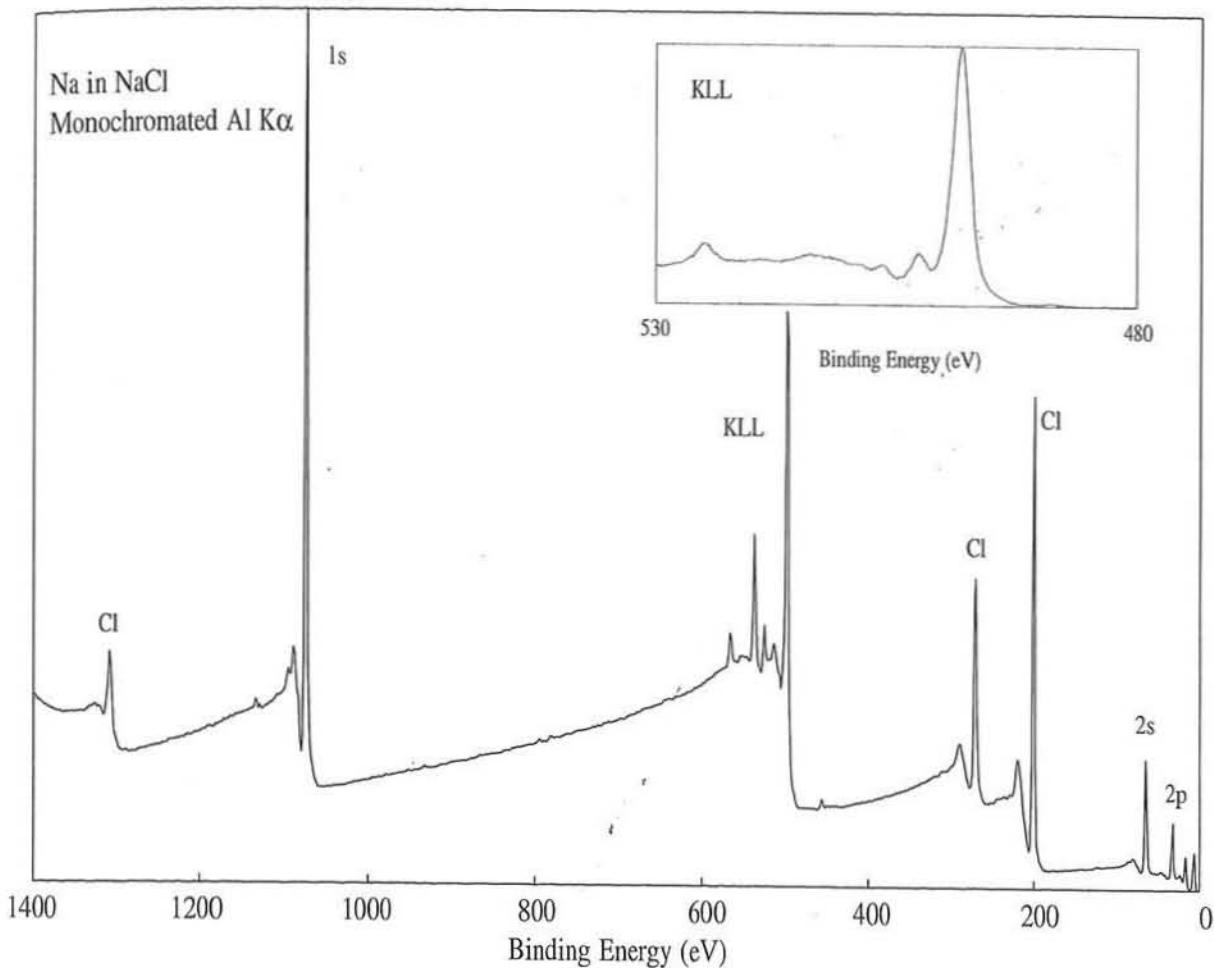
Photoelectron Lines

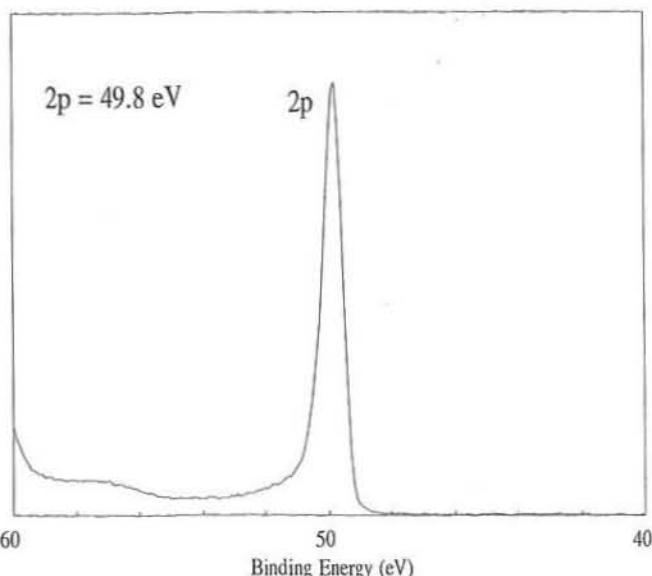
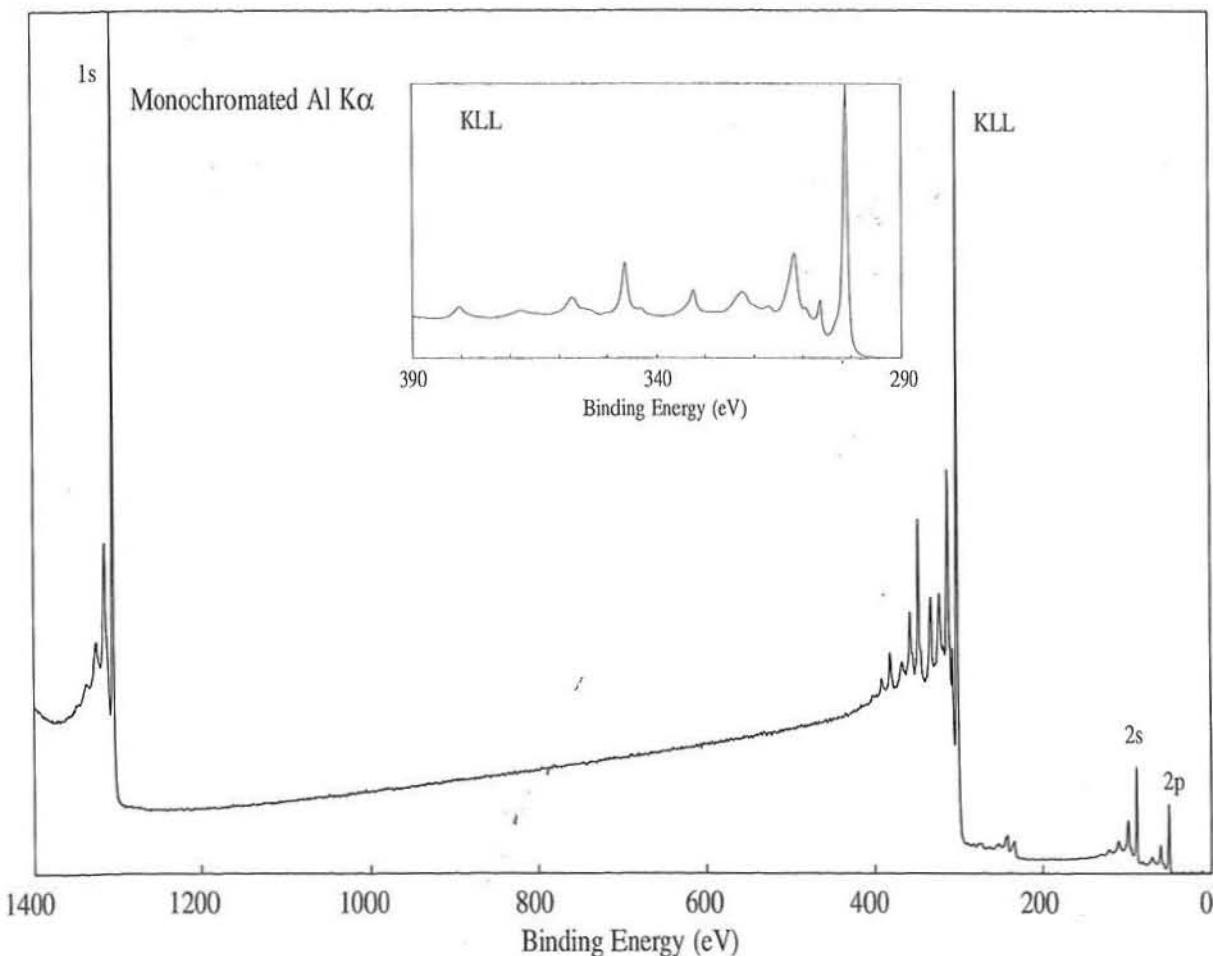
1s	2s	2p
1072	64	31

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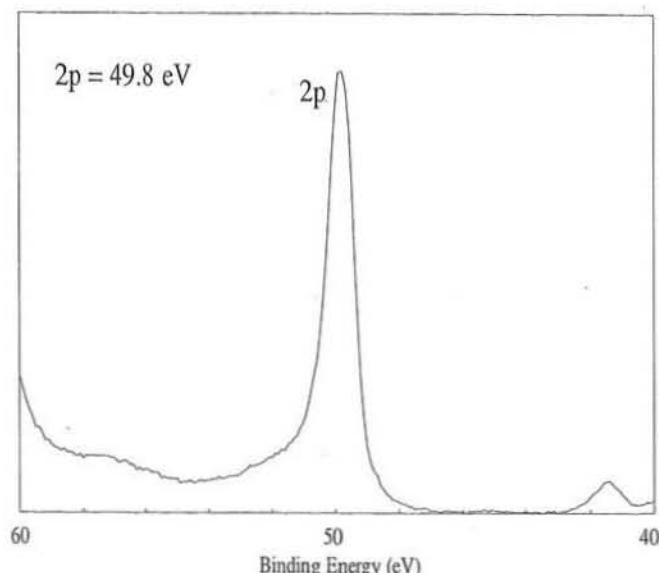
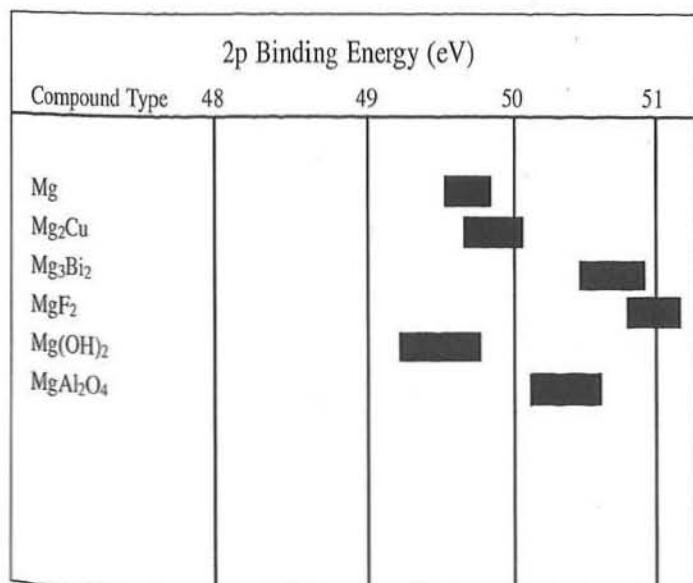
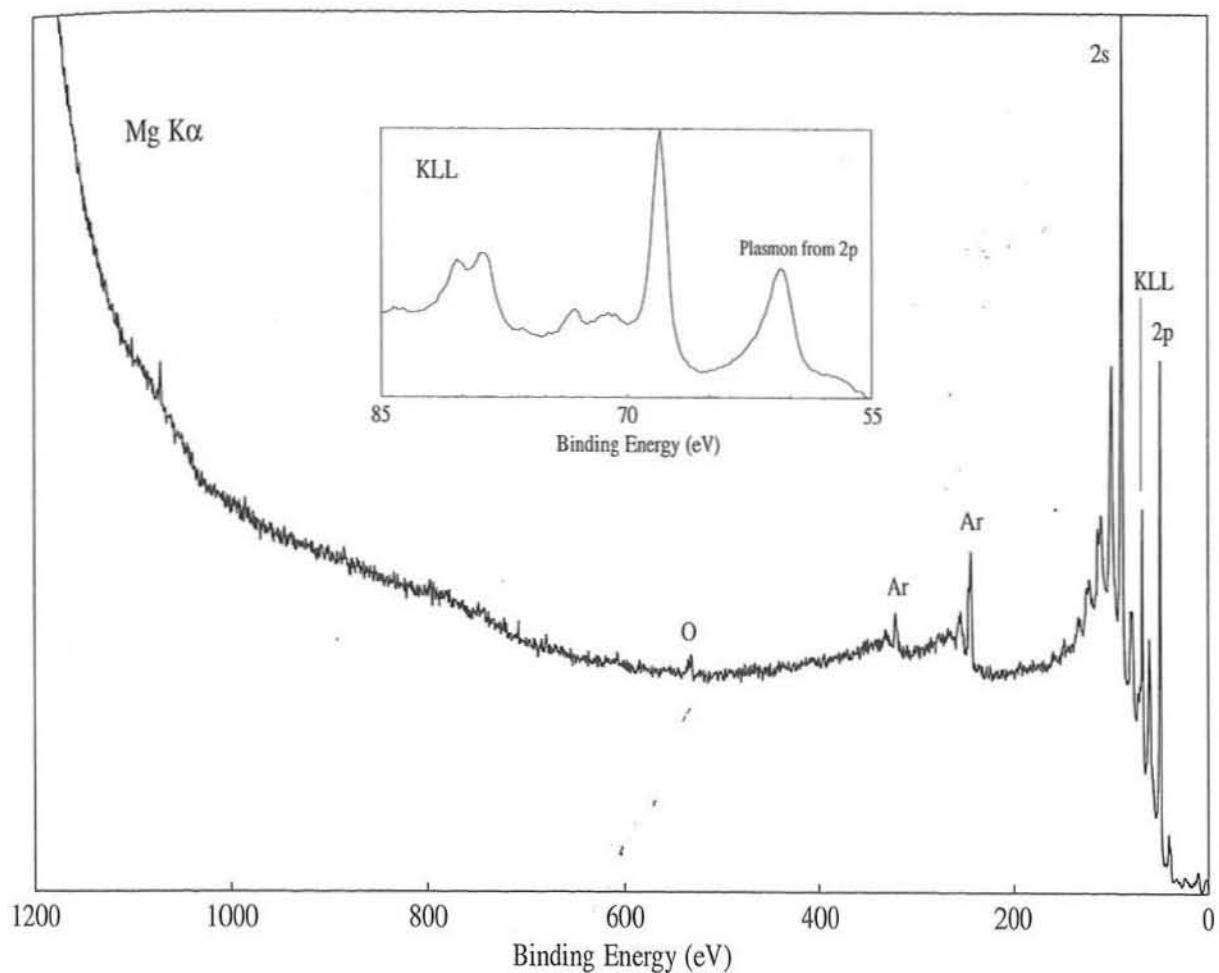
Auger Lines

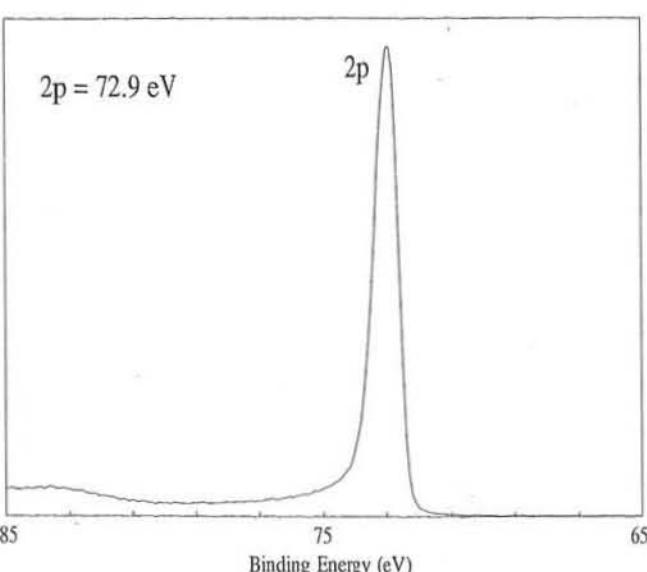
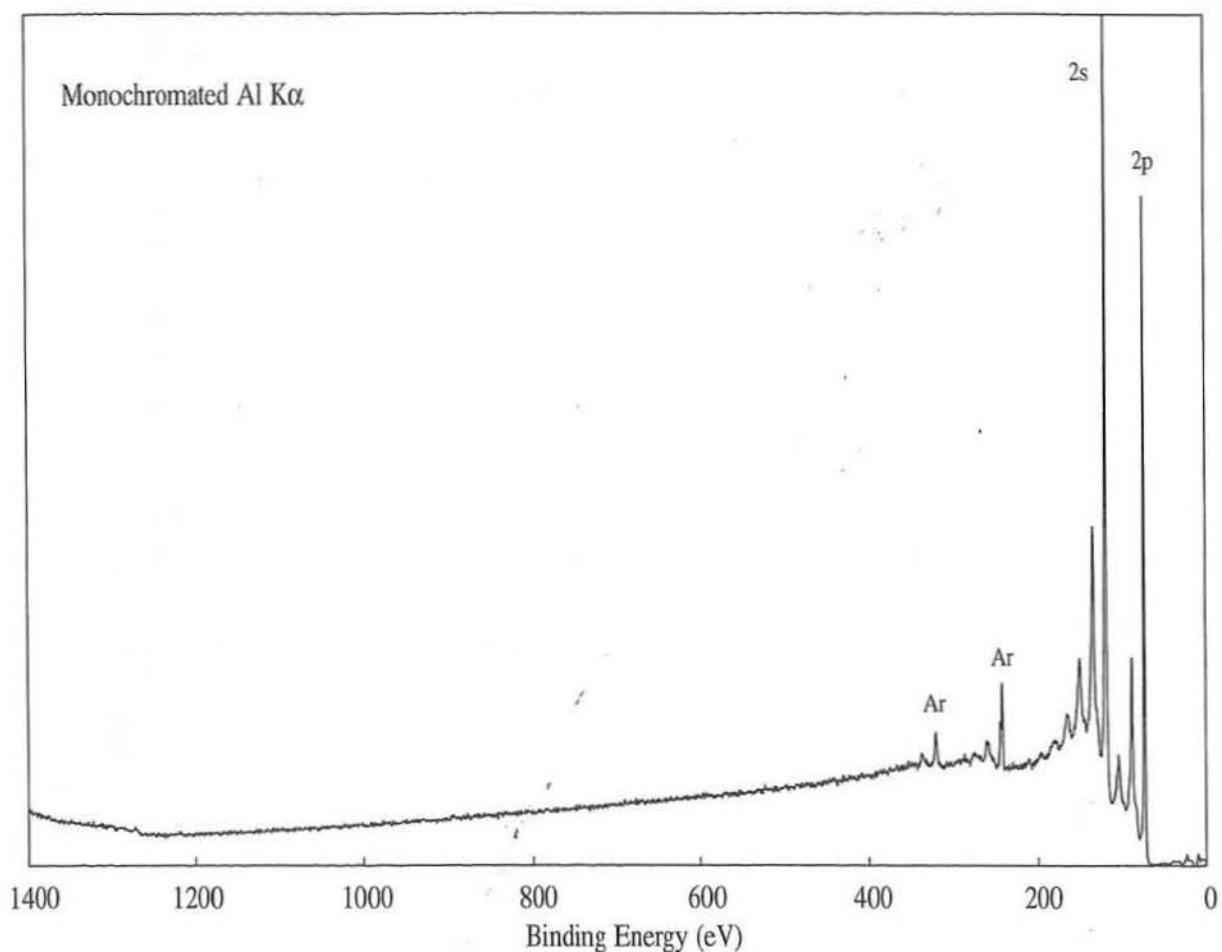
KL <sub>1</sub> L <sub>1</sub>	KL <sub>1</sub> L <sub>23</sub>	KL <sub>23</sub> L <sub>23</sub>
561	532	493 (Al)
328	299	260 (Mg)





Line Positions (eV)		
<u>Photoelectron Lines</u>		
ls	2s	2p
1303	89	50
<u>Auger Lines</u>		
KL <sub>1</sub> L <sub>1</sub>	KL <sub>1</sub> L <sub>23</sub>	KL <sub>23</sub> L <sub>23</sub>
381	347	301 (Al)
148	114	68 (Mg)





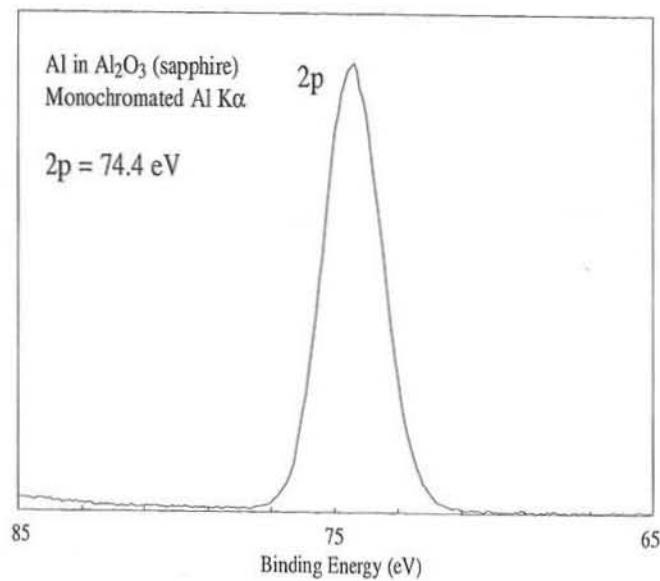
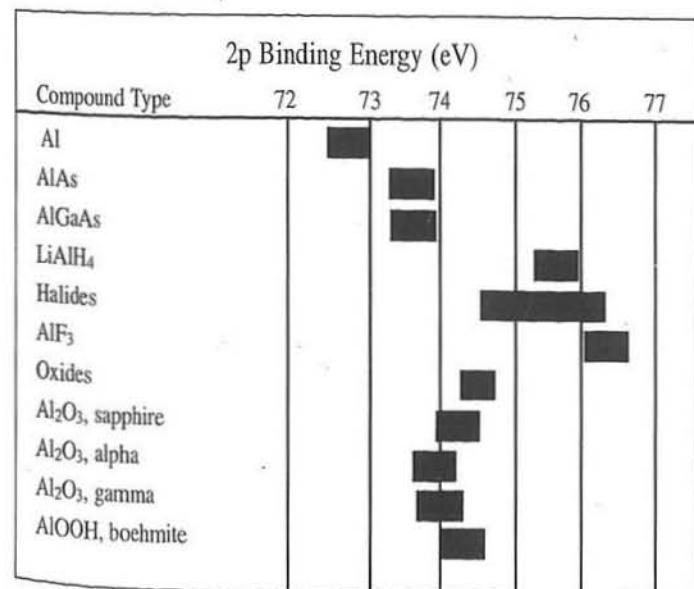
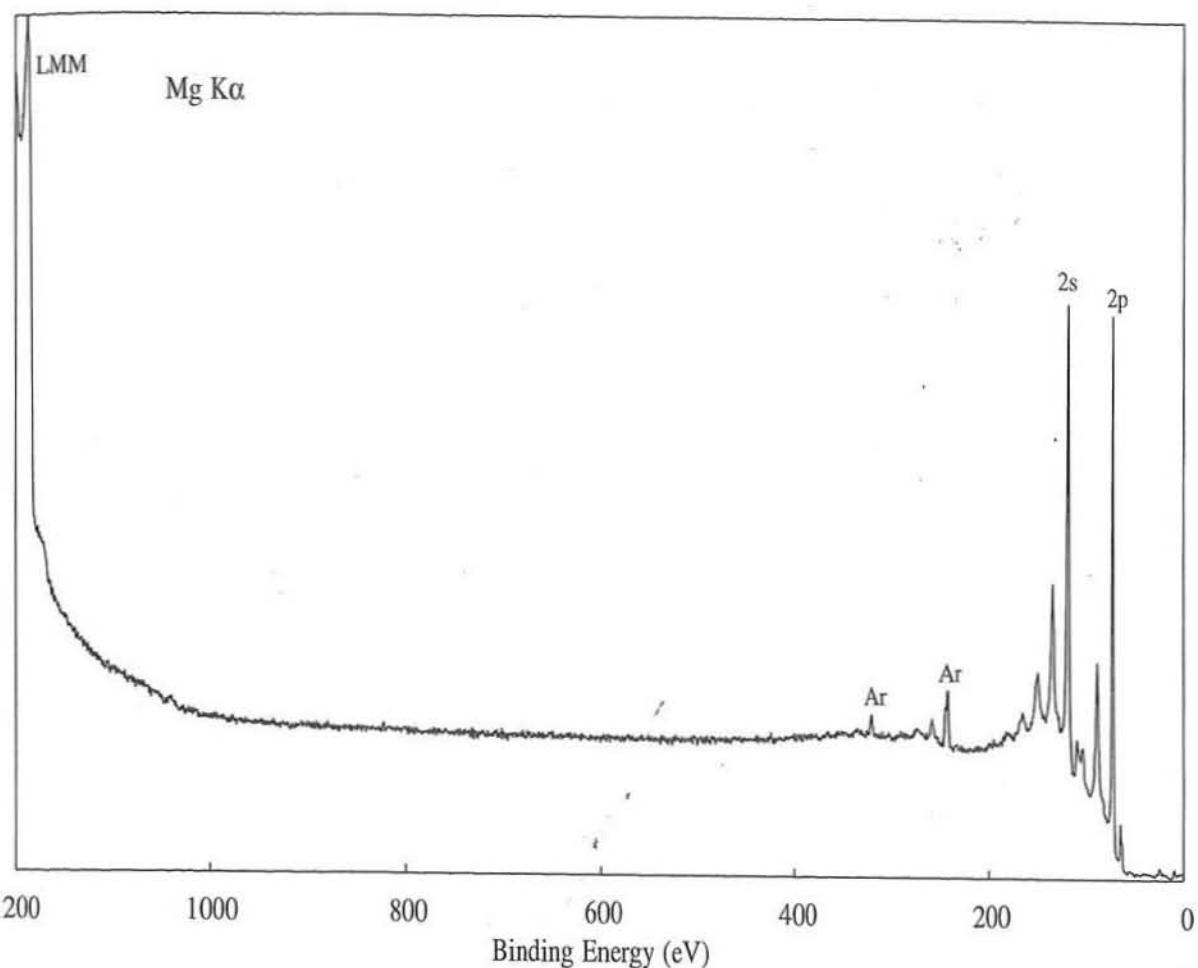
Line Positions (eV)

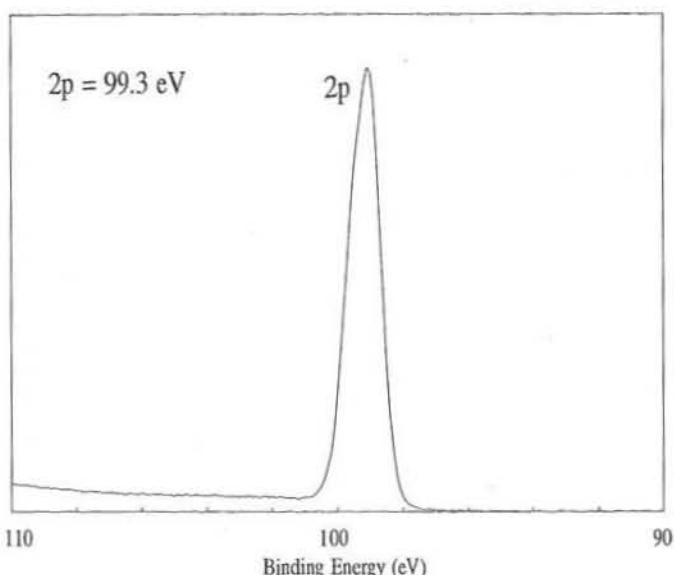
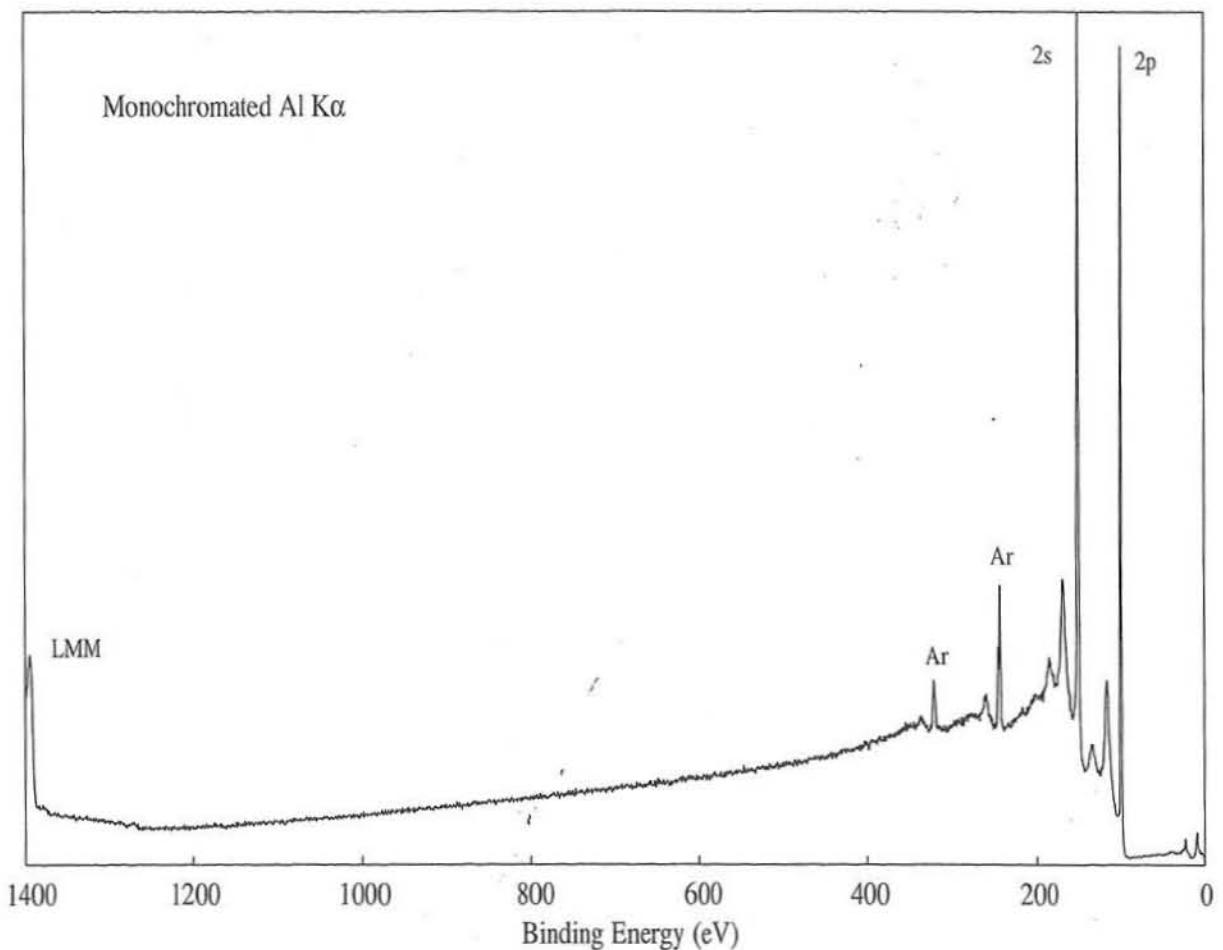
Photoelectron Lines

2s	2p
118	73

Auger Lines

L <sub>23</sub> M <sub>1</sub> M <sub>23</sub>
1419 (Al)
1186 (Mg)





Line Positions (eV)

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Photoelectron Lines

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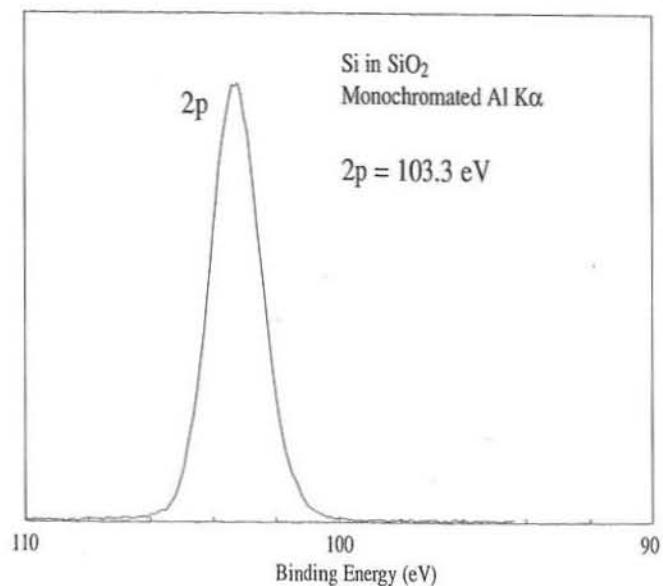
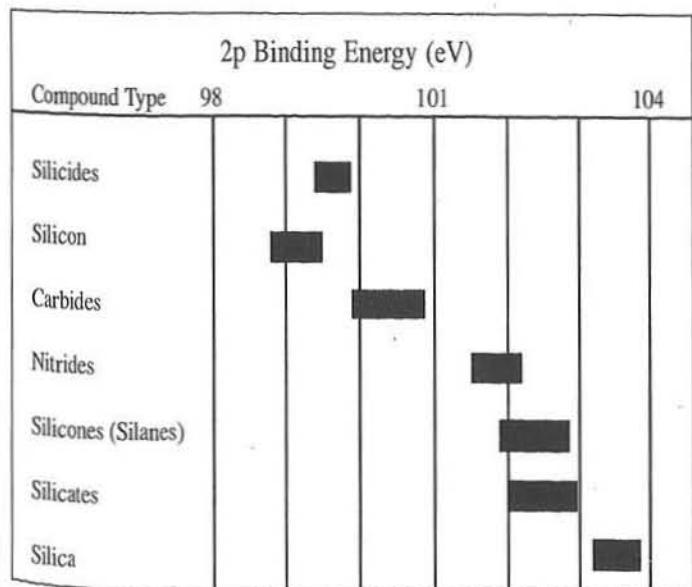
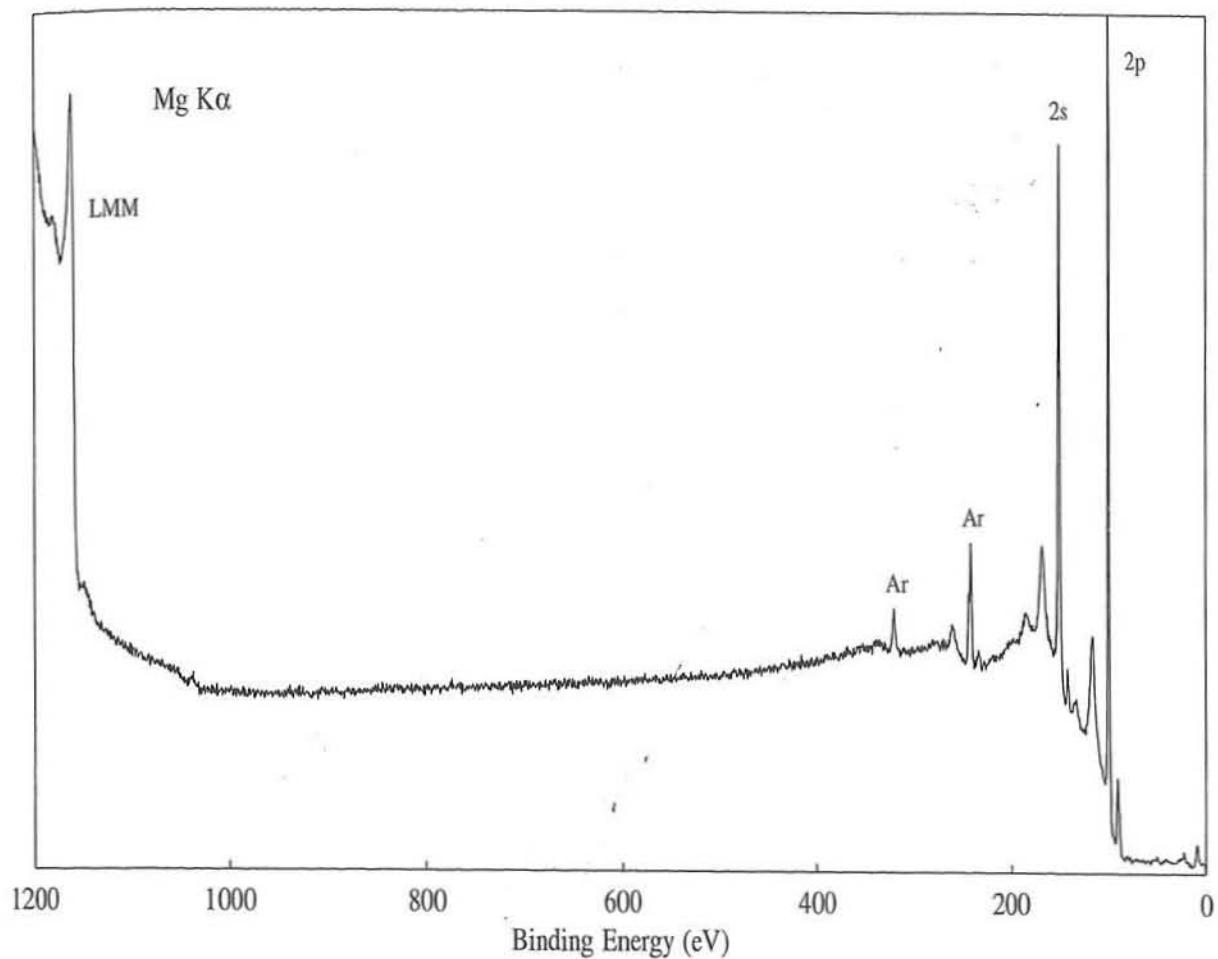
2s	2p
151	99

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Auger Lines

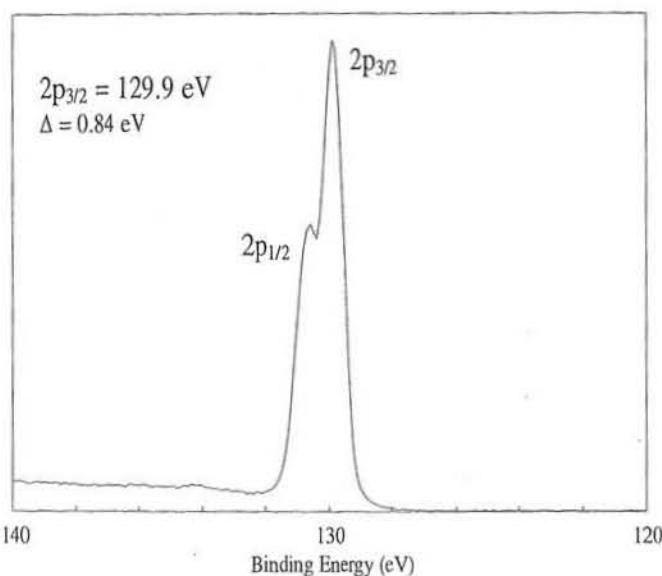
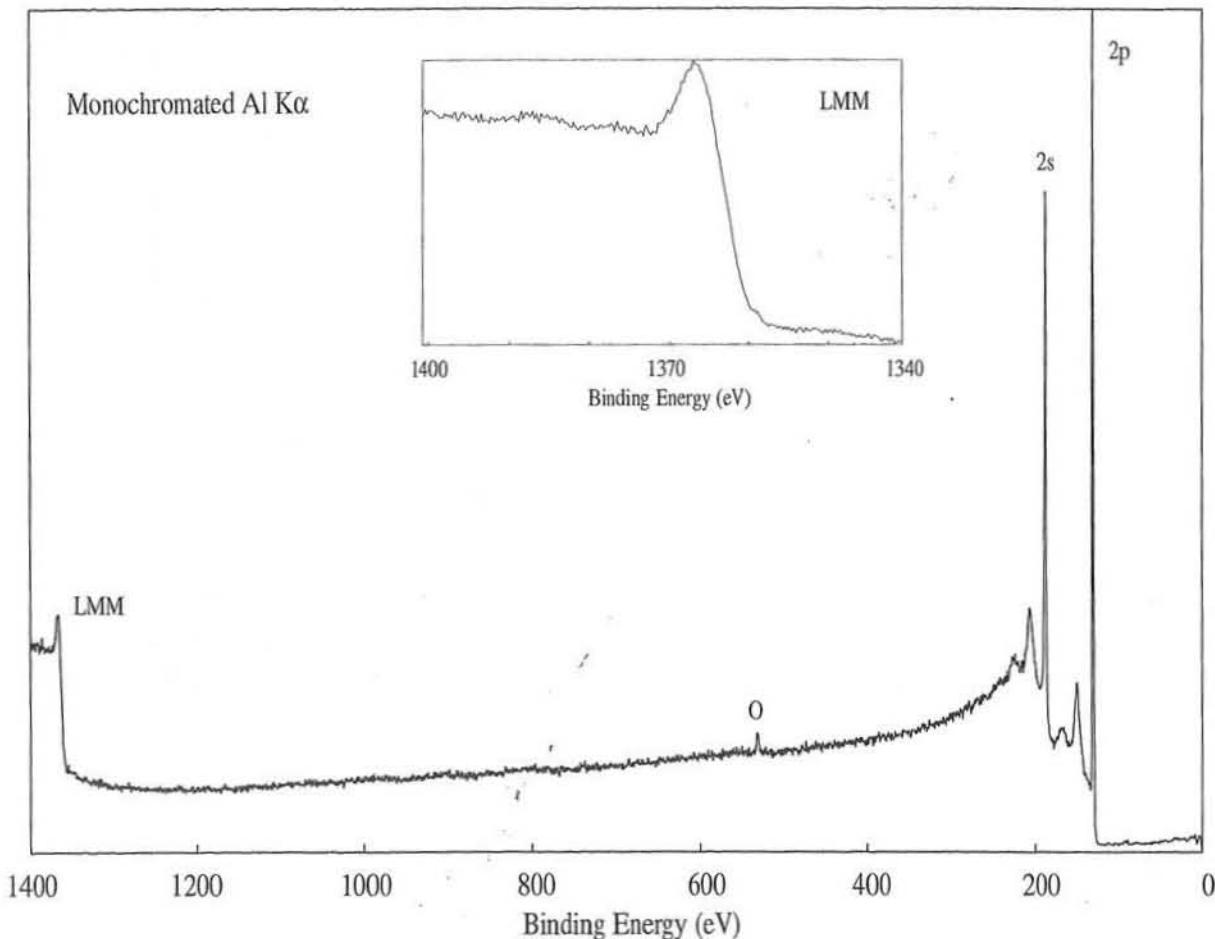
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L <sub>23</sub> M <sub>23</sub> M <sub>23</sub>
1394      (Al)
1161      (Mg)



**Phosphorus P**  
Atomic Number 15

**Handbook of X-ray Photoelectron Spectroscopy**



**Line Positions (eV)**

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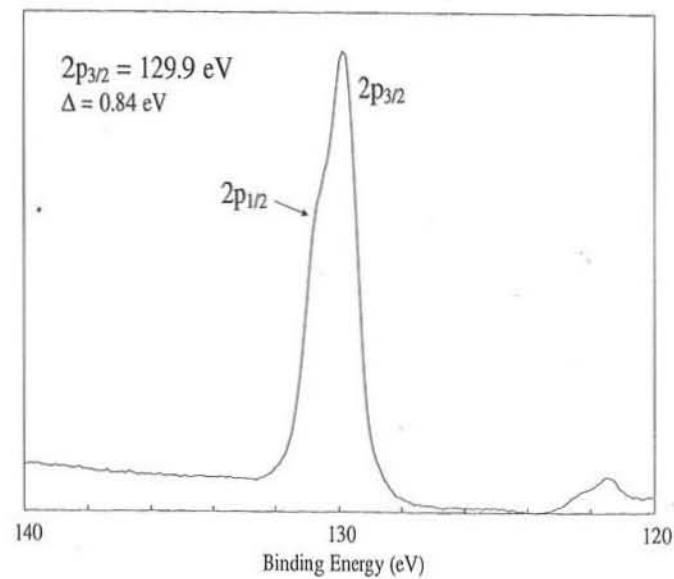
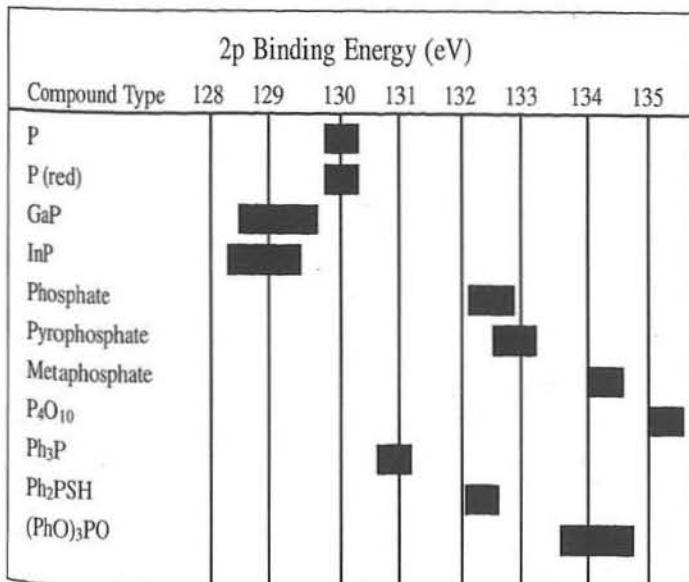
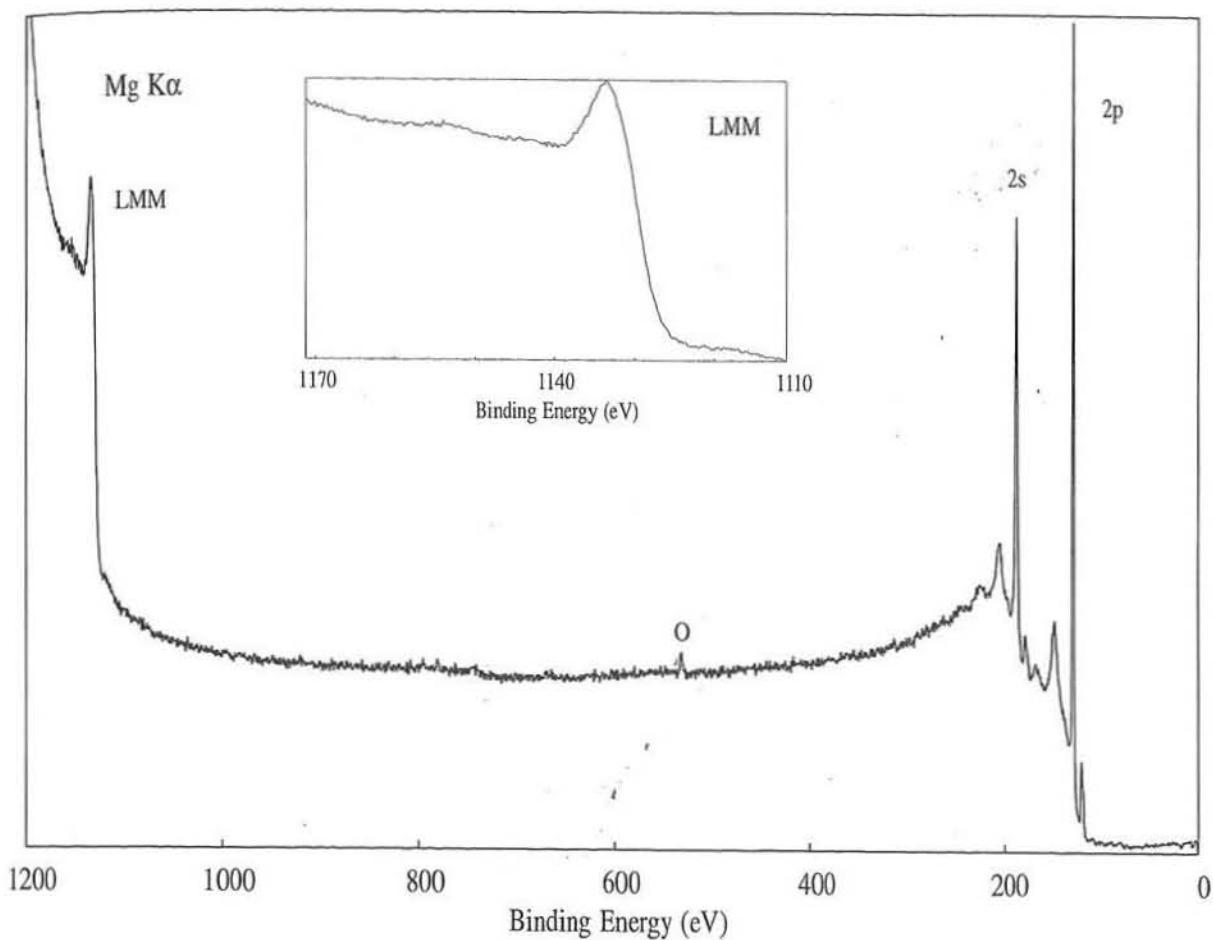
Photoelectron Lines

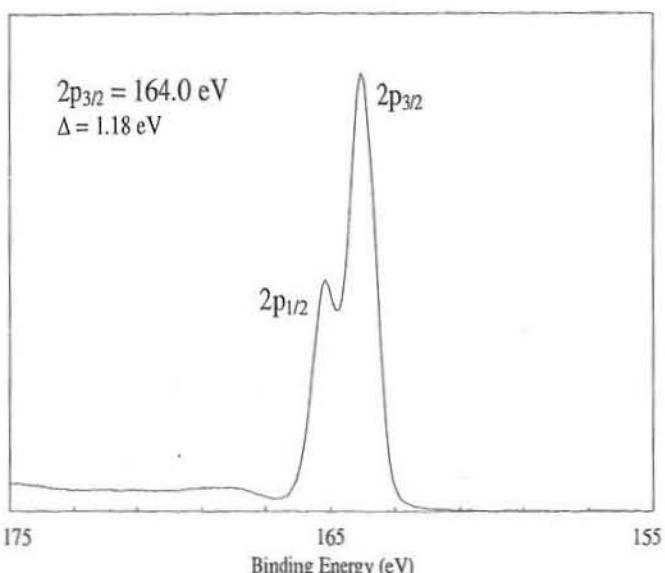
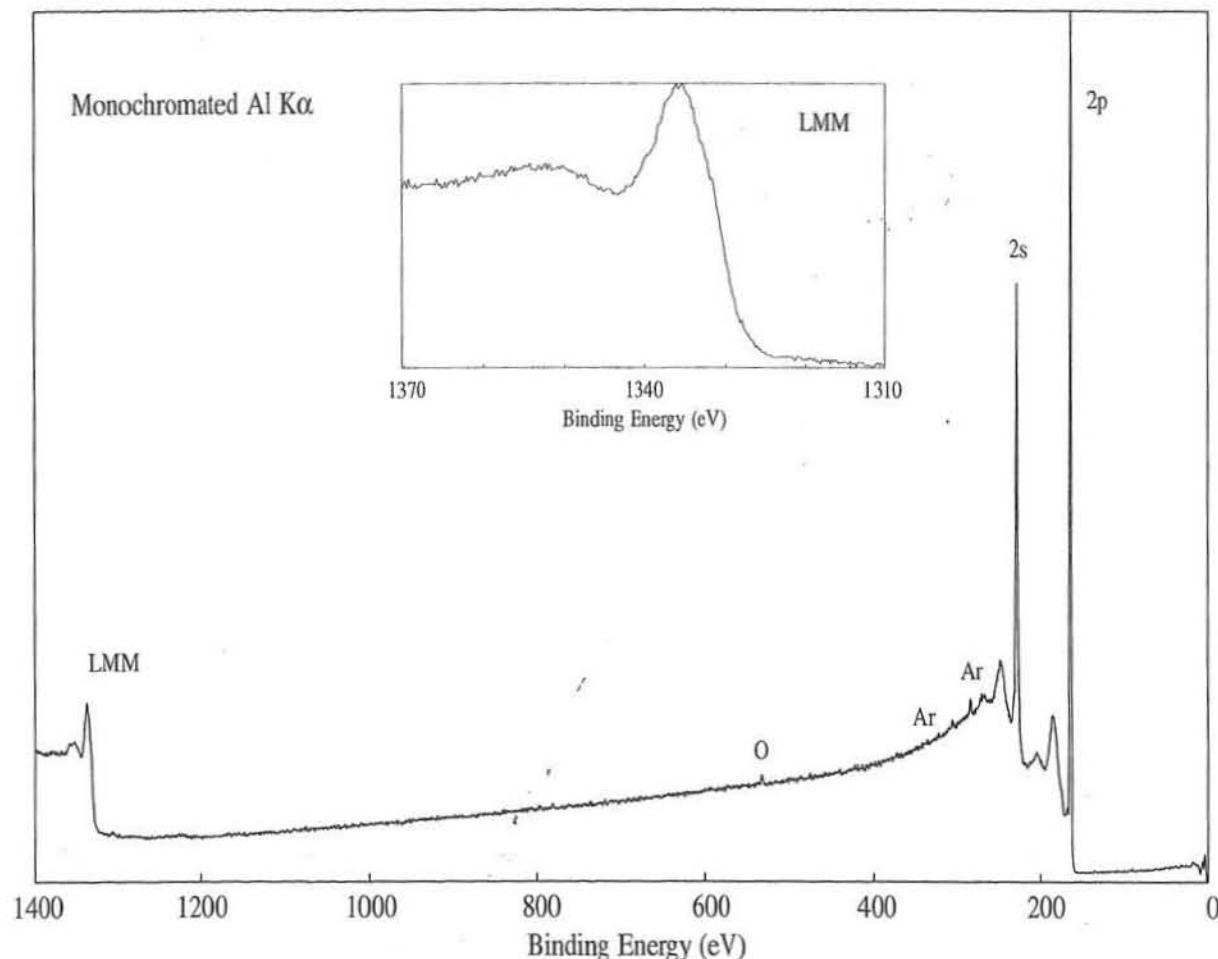
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s
188	131	130	14

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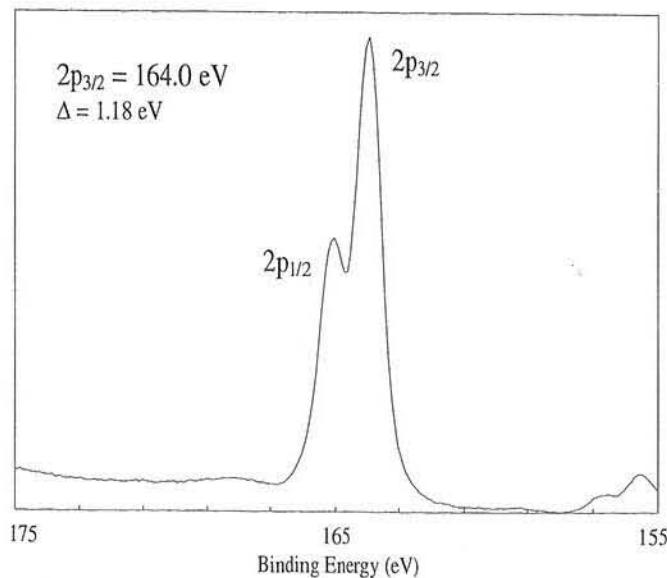
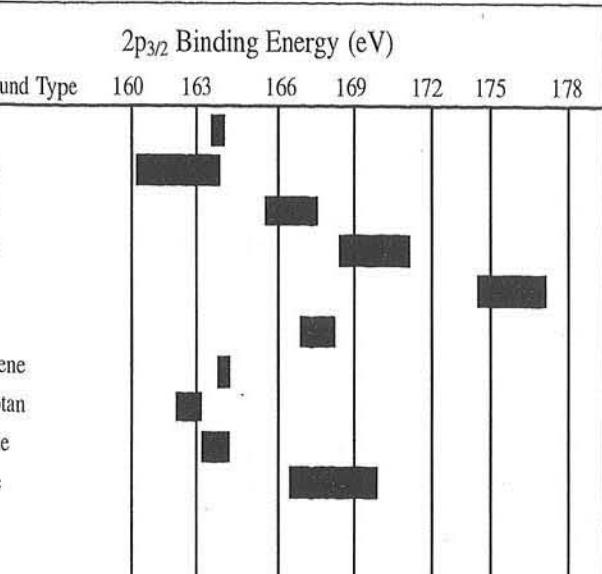
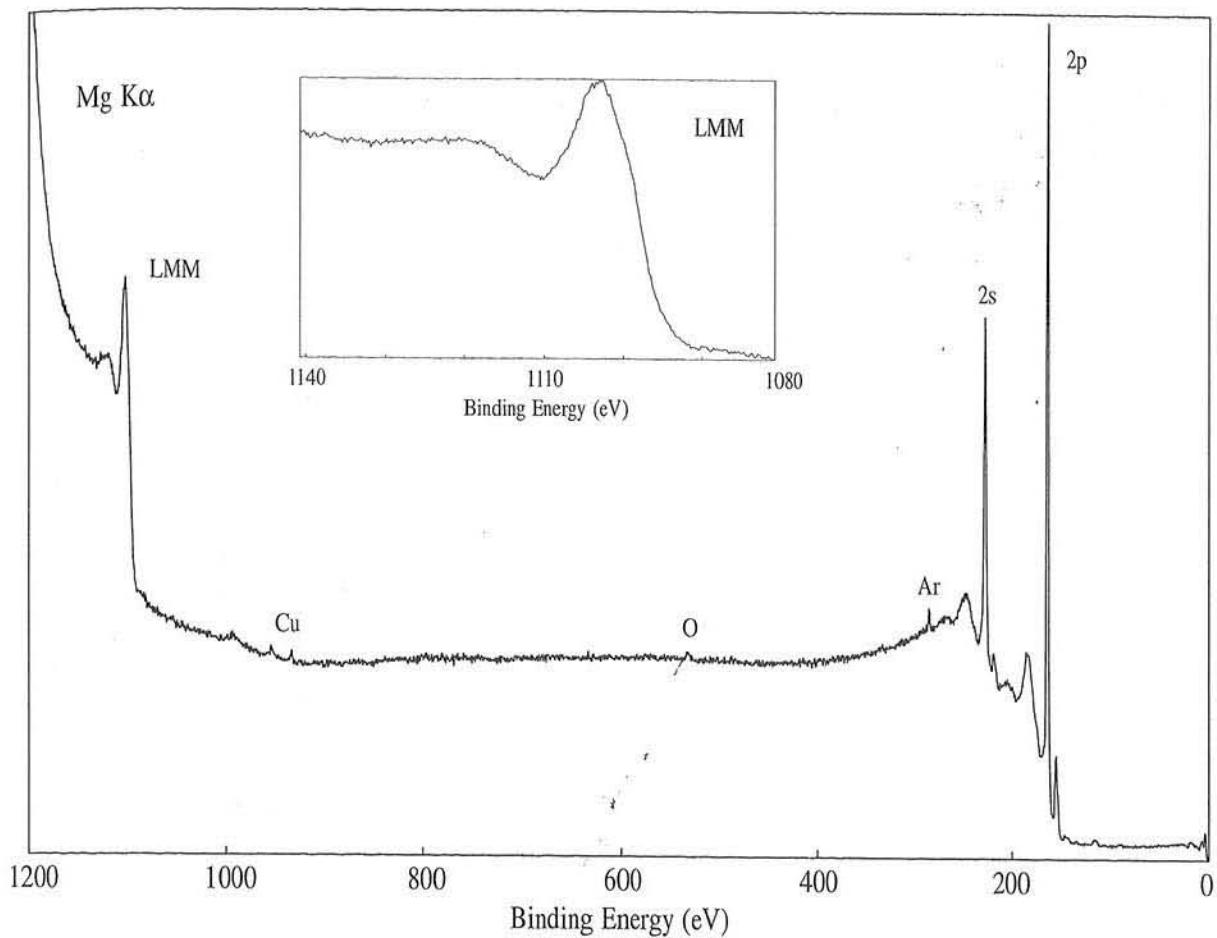
Auger Lines

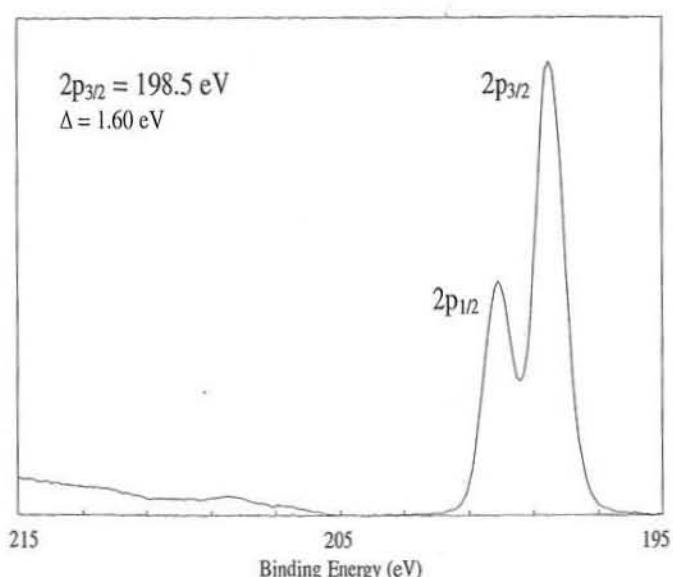
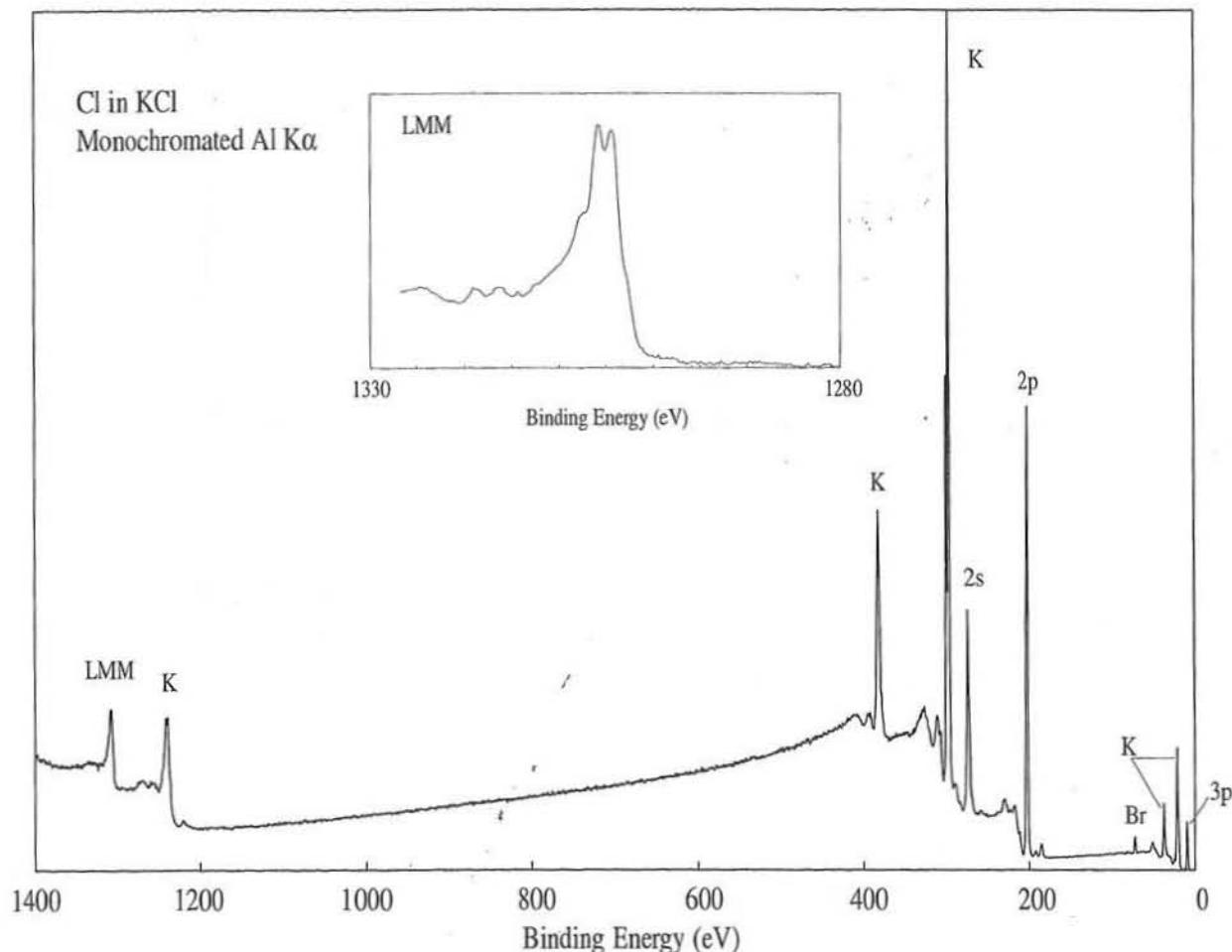
L <sub>23</sub> M <sub>23</sub> M <sub>23</sub>
1367 (Al)
1134 (Mg)





Line Positions (eV)			
<u>Photoelectron Lines</u>			
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s
228	165	164	18
<u>Auger Lines</u>			
L <sub>23</sub> M <sub>23</sub> M <sub>23</sub>			
1336 (Al)			
1103 (Mg)			





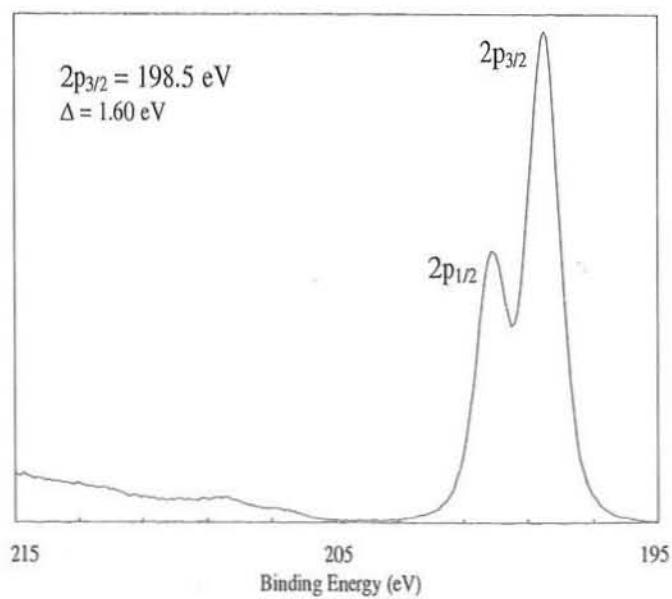
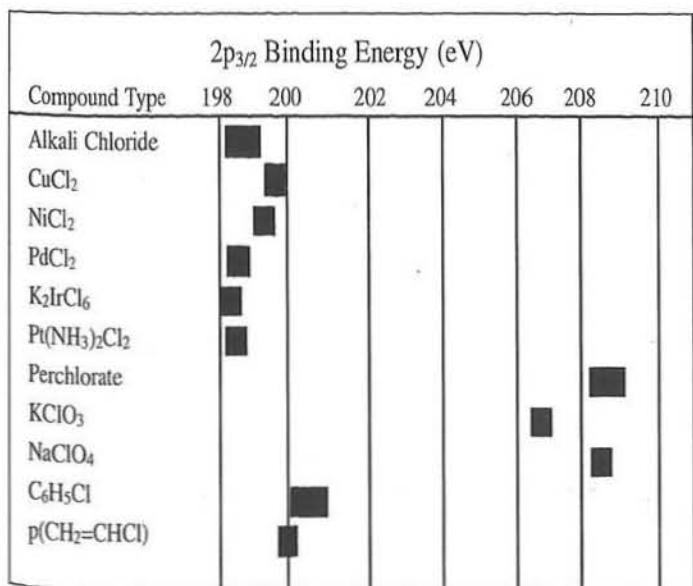
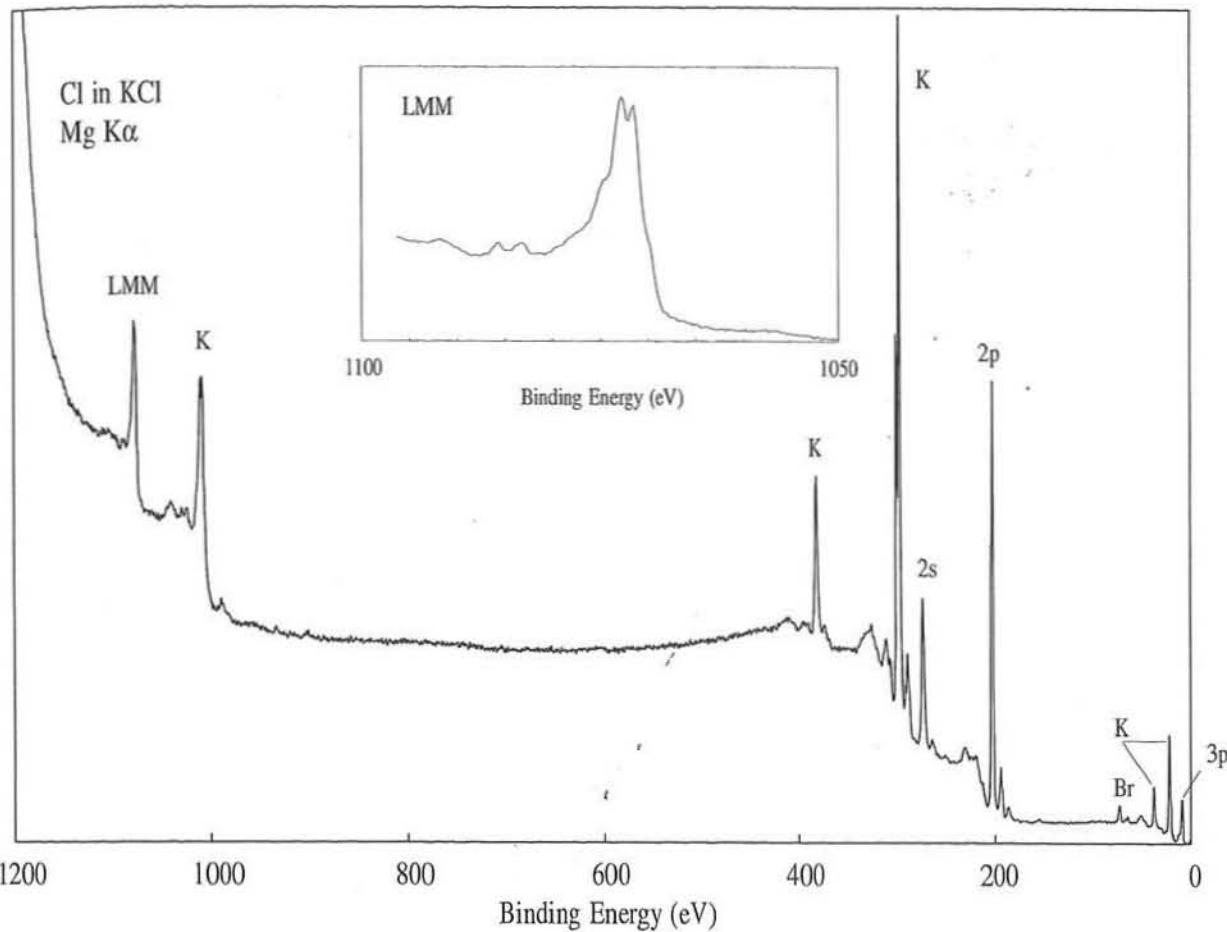
Line Positions (eV)

Photoelectron Lines

2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p
271	201	199	17	6

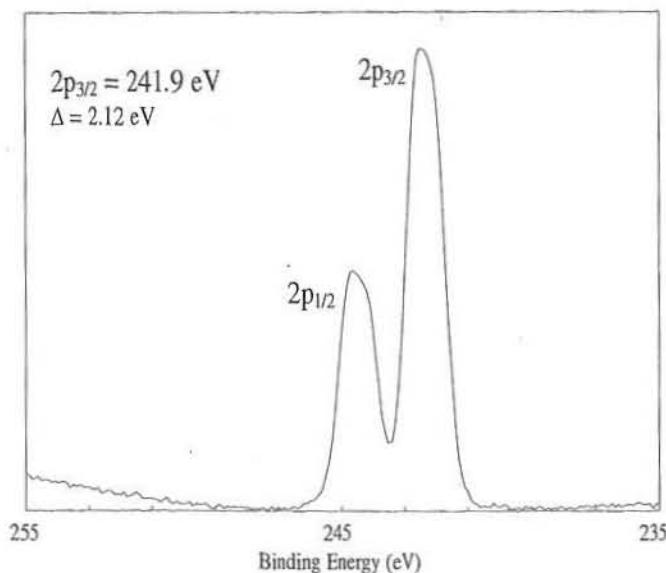
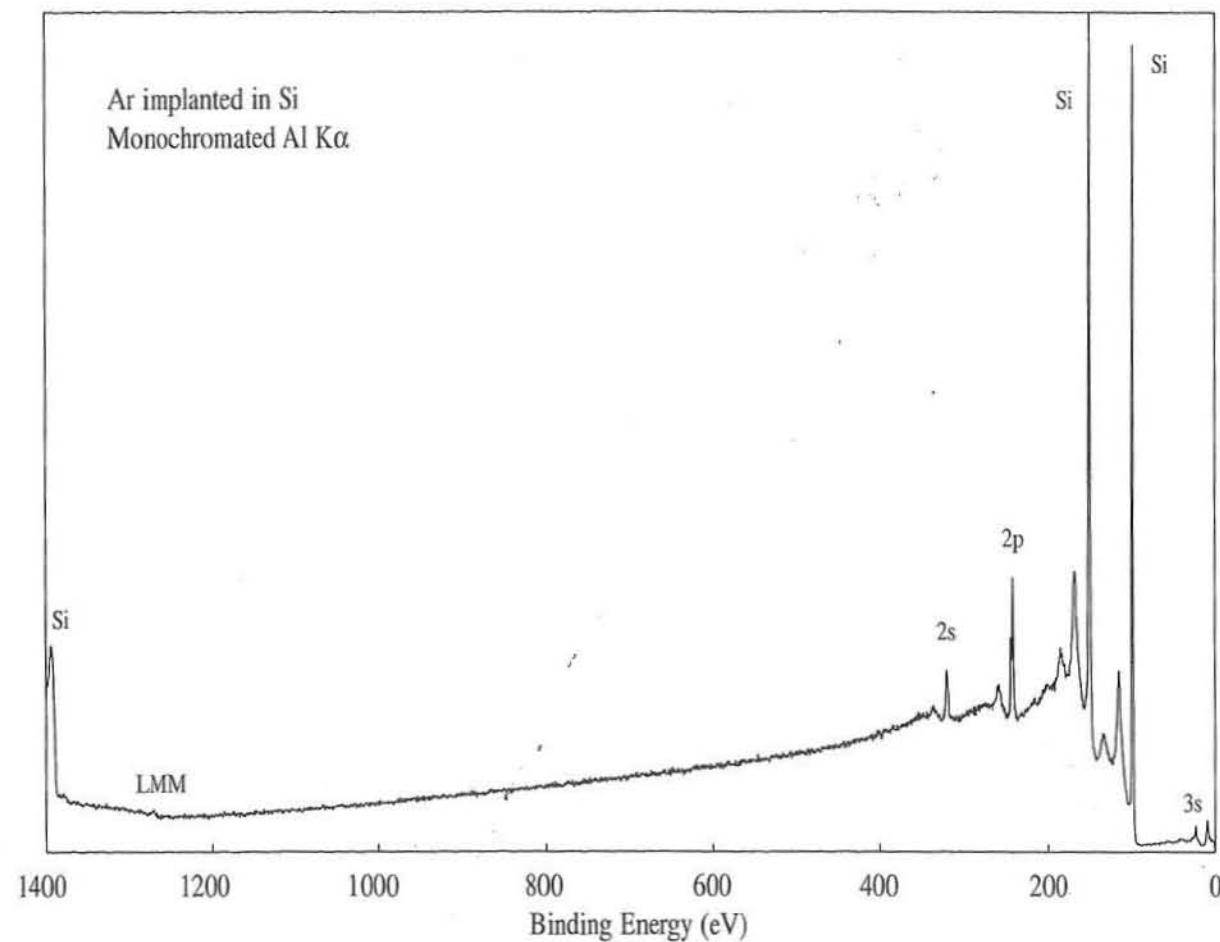
Auger Lines

L <sub>23</sub> M <sub>23</sub> M <sub>23</sub>	
1304	(Al)
1071	(Mg)



Argon      Ar  
Atomic Number 18

Handbook of X-ray Photoelectron Spectroscopy



Line Positions (eV)

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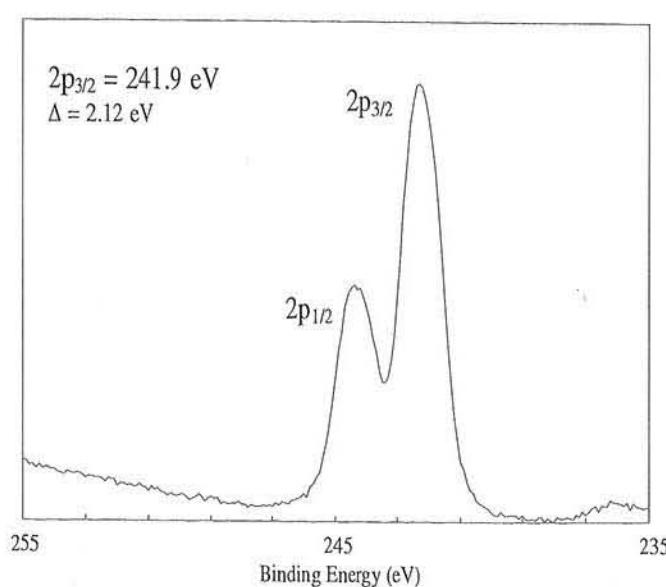
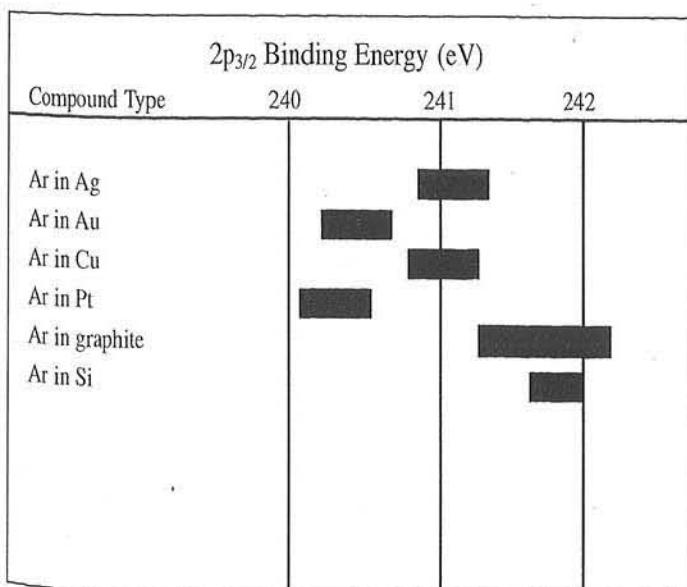
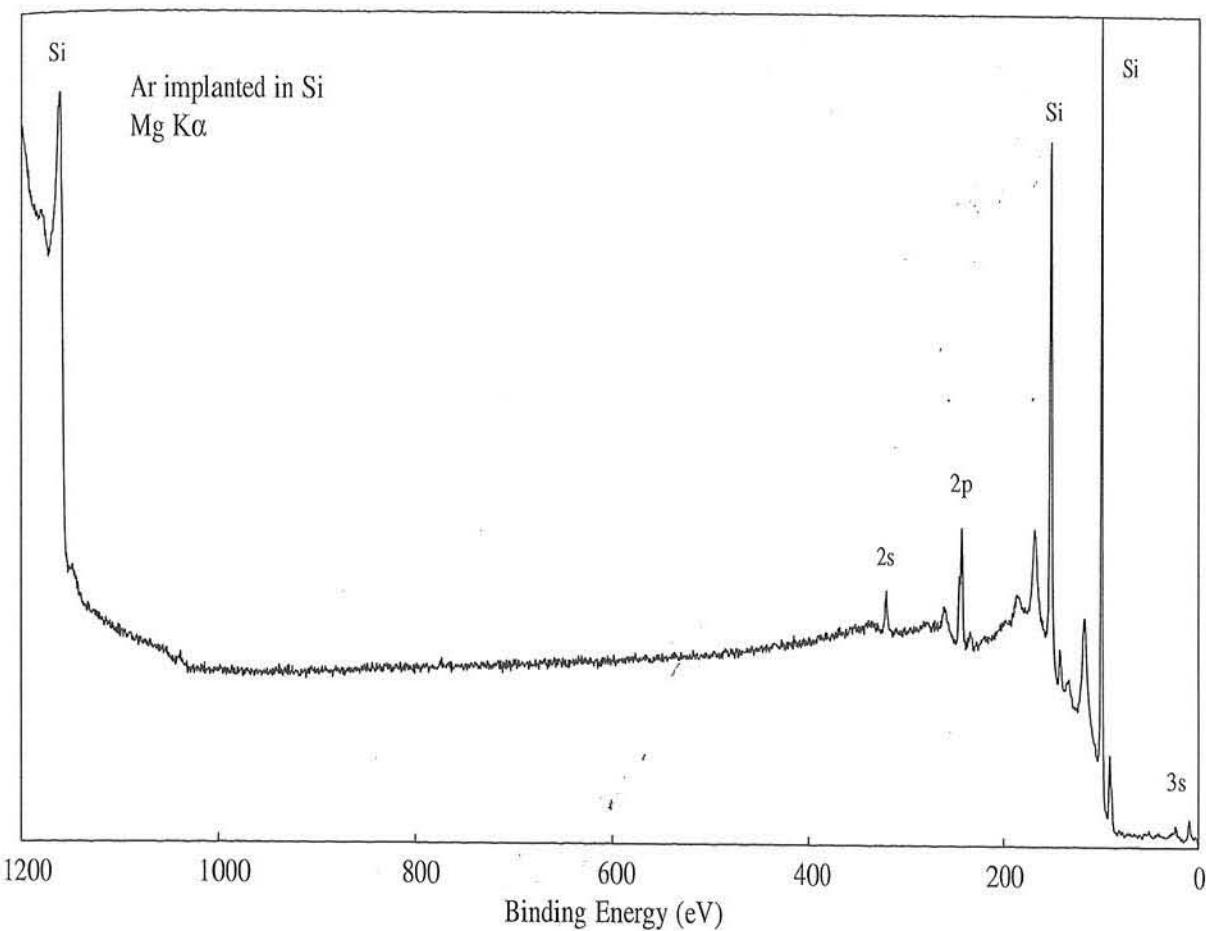
Photoelectron Lines

2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s
320	244	242	24

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Auger Lines

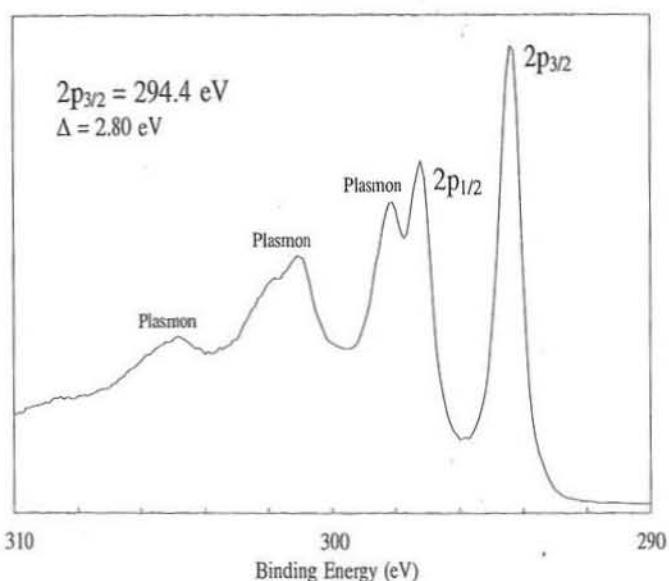
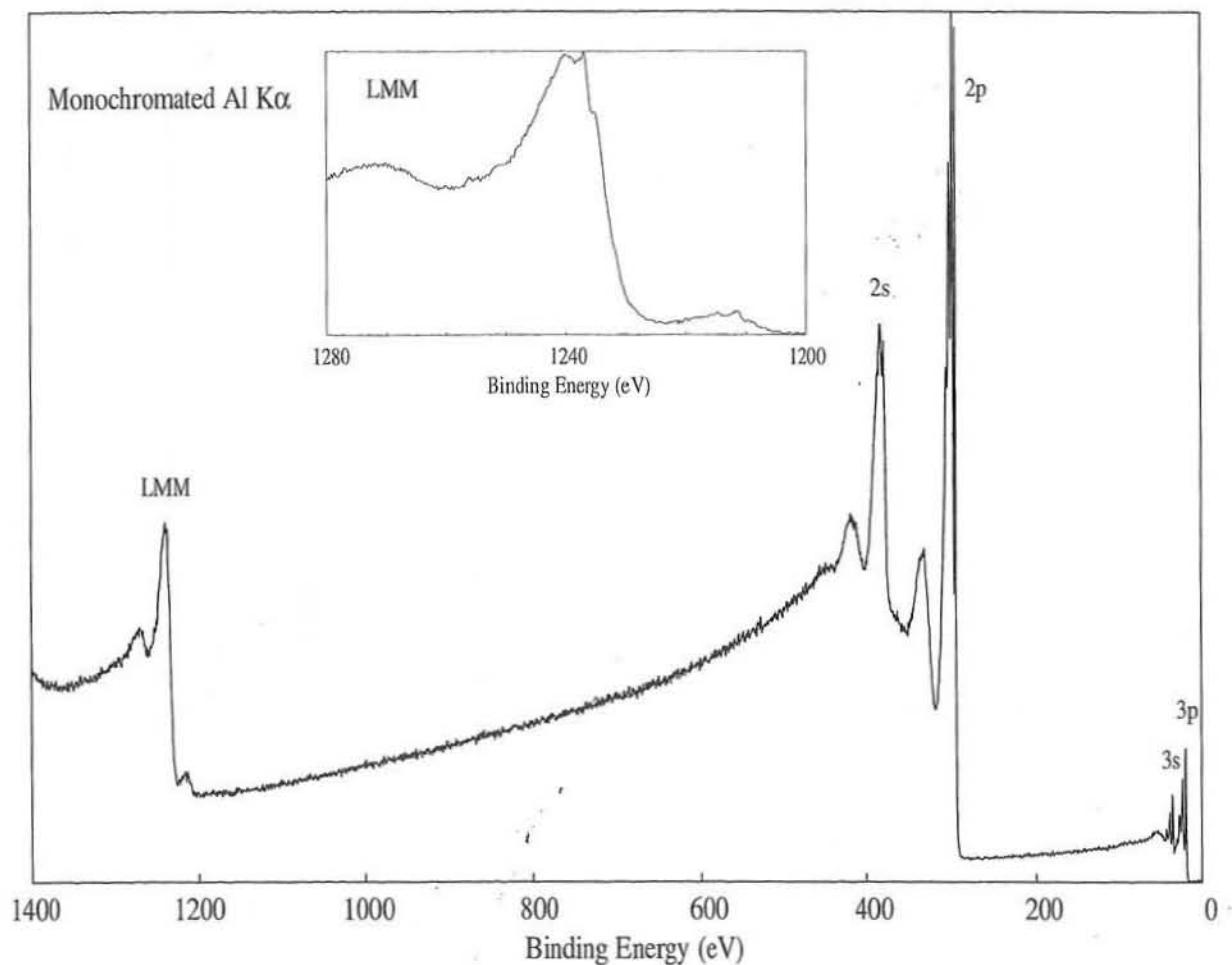
L <sub>23</sub> M <sub>23</sub> M <sub>23</sub>
1272 (Al)
1039 (Mg)



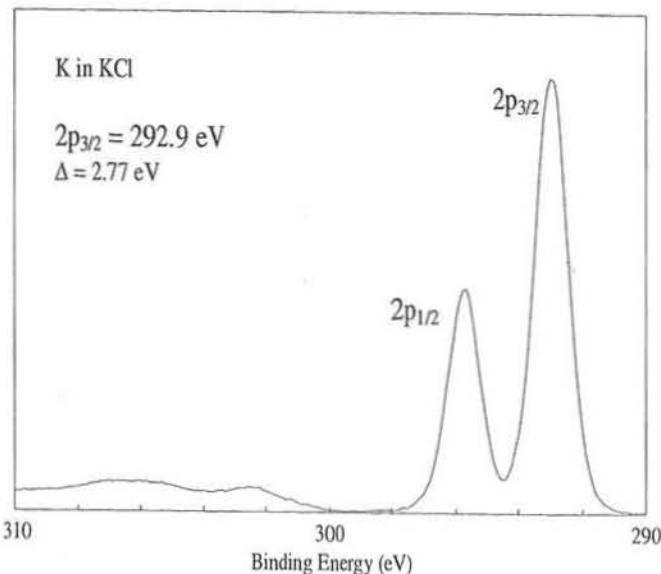
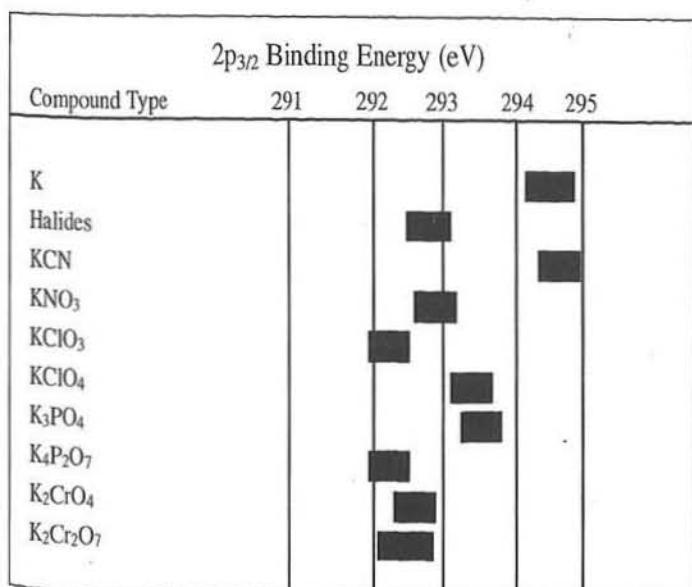
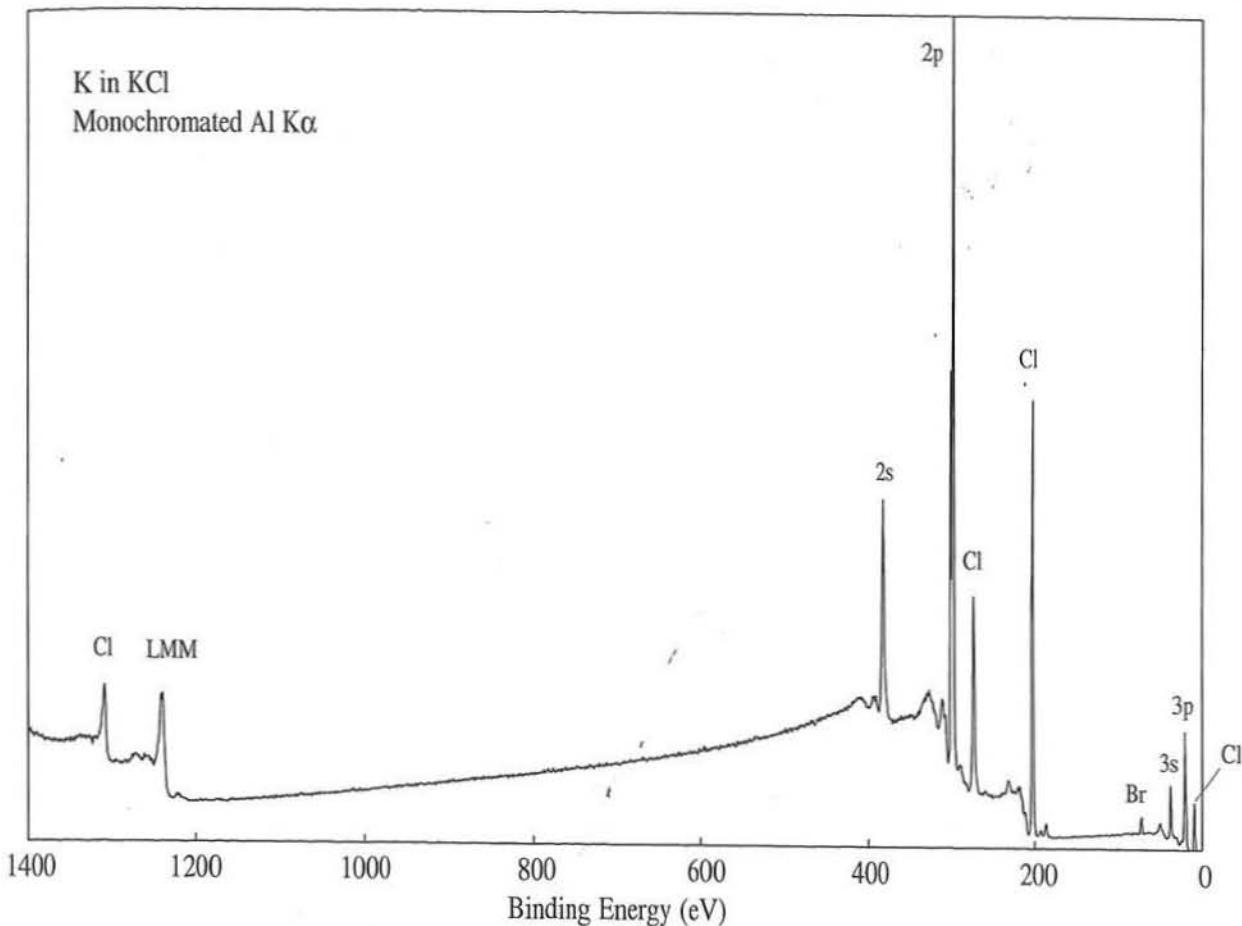
# Potassium K

Atomic Number 19

## Handbook of X-ray Photoelectron Spectroscopy



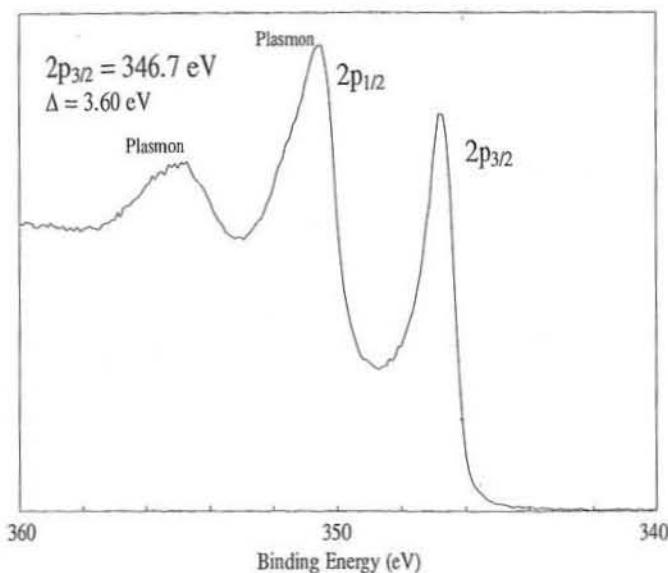
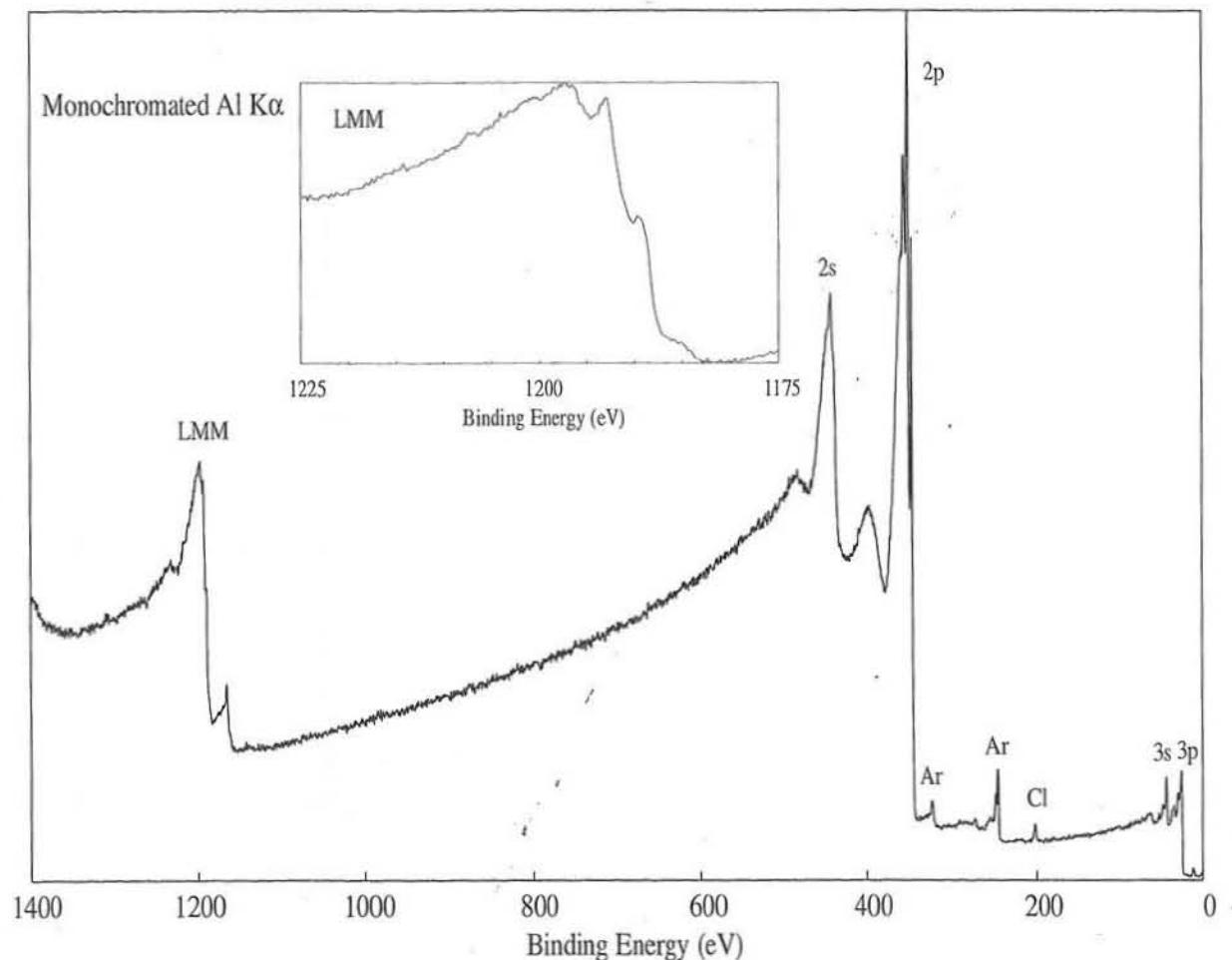
Line Positions (eV)				
<u>Photoelectron Lines</u>				
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p
380	297	294	35	19
<u>Auger Lines</u>				
$L_{23}M_{23}M_{23}$				
1239 (Al)				
1006 (Mg)				



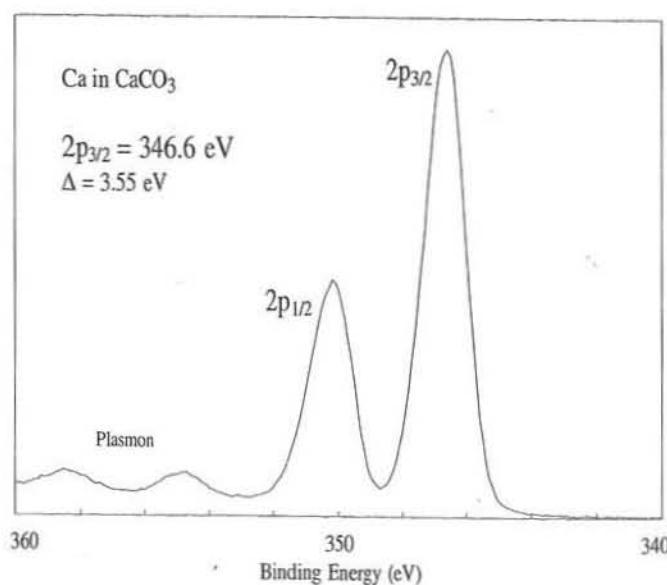
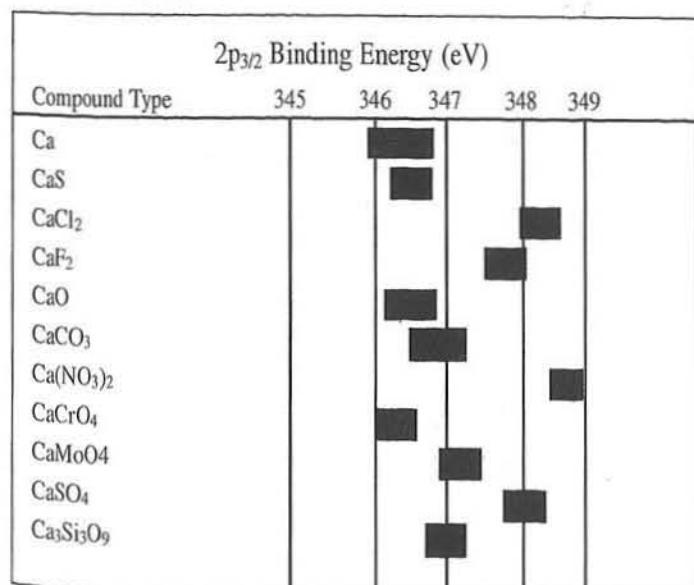
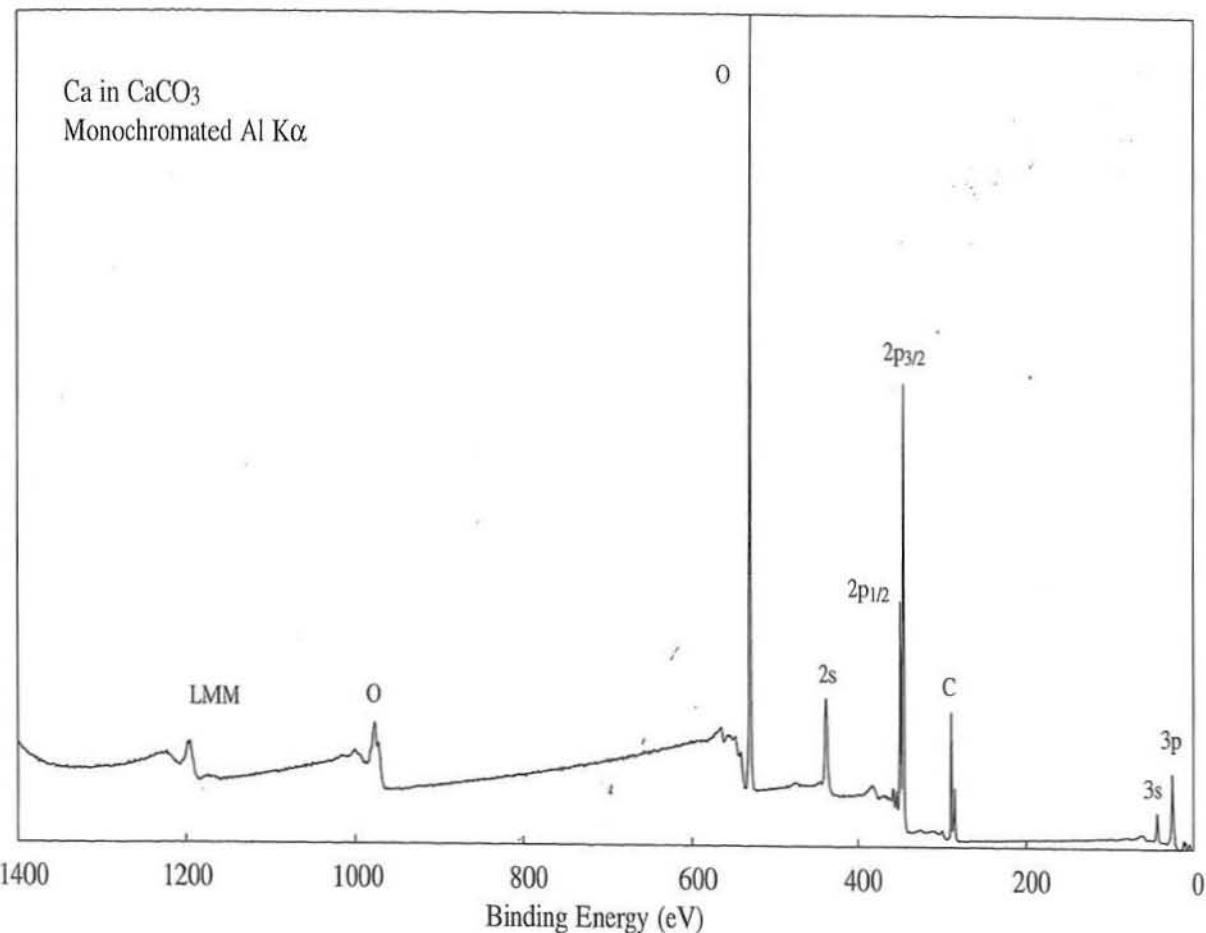
# Calcium Ca

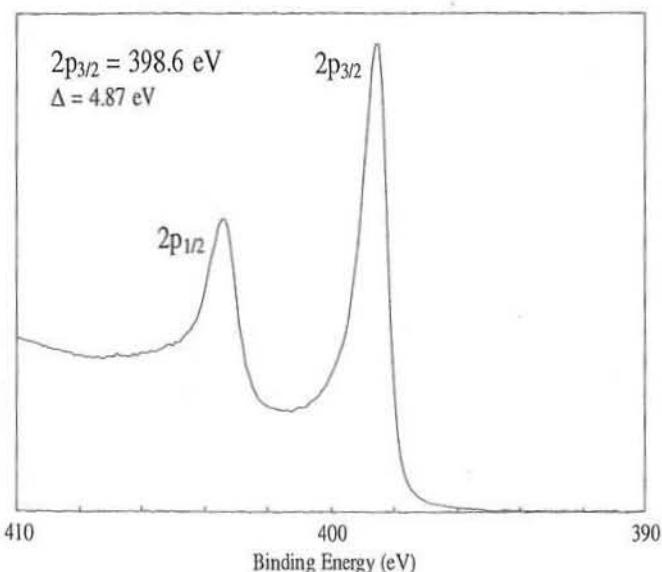
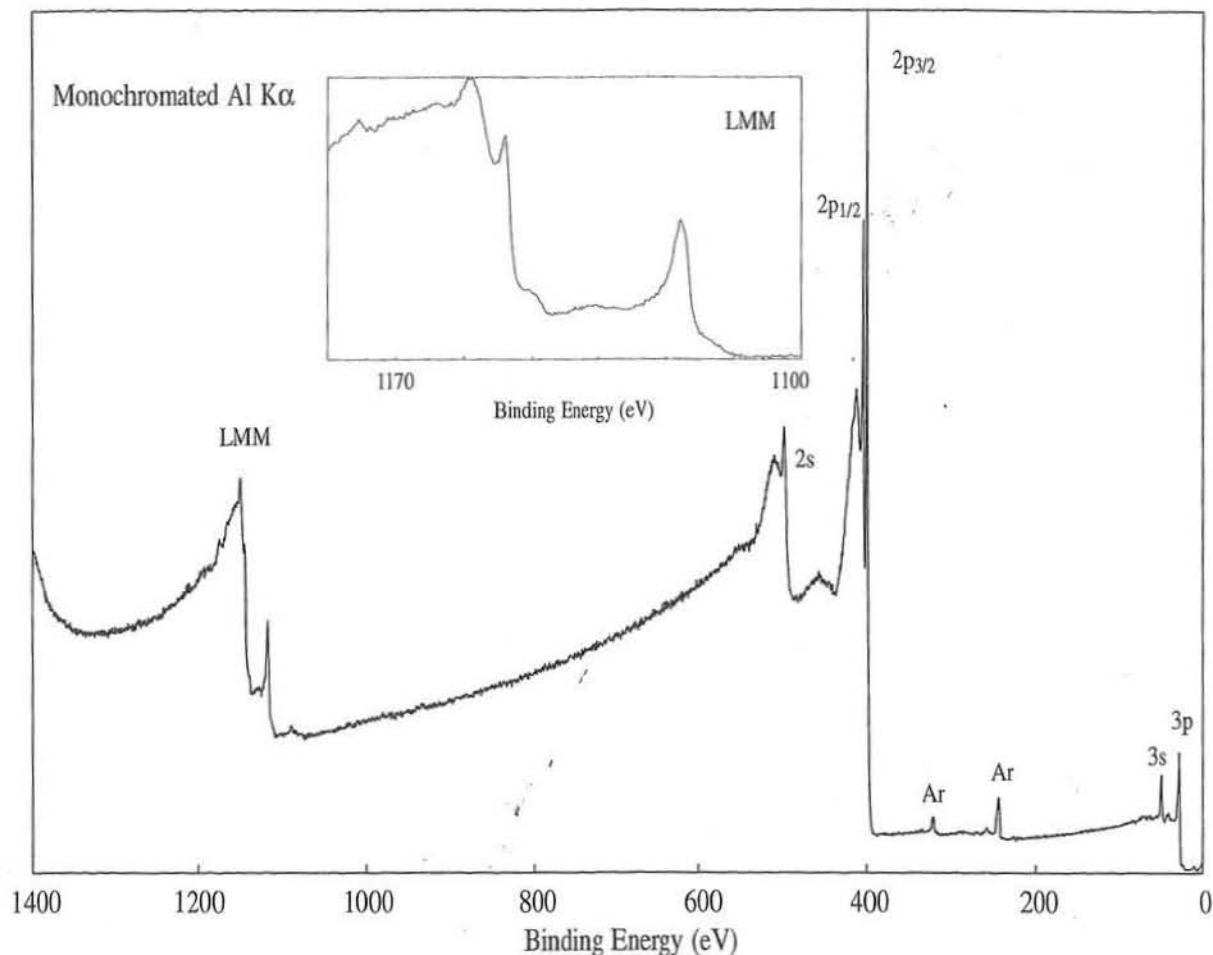
Atomic Number 20

## Handbook of X-ray Photoelectron Spectroscopy



Line Positions (eV)				
Photoelectron Lines				
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p
440	351	347	45	26
Auger Lines				
$L_{23}M_{23}M_{23}$				
1197 (Al)				
964 (Mg)				





Line Positions (eV)

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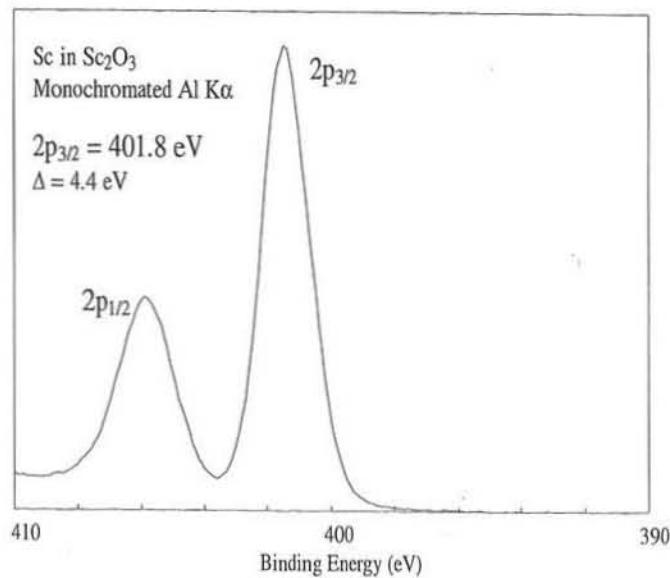
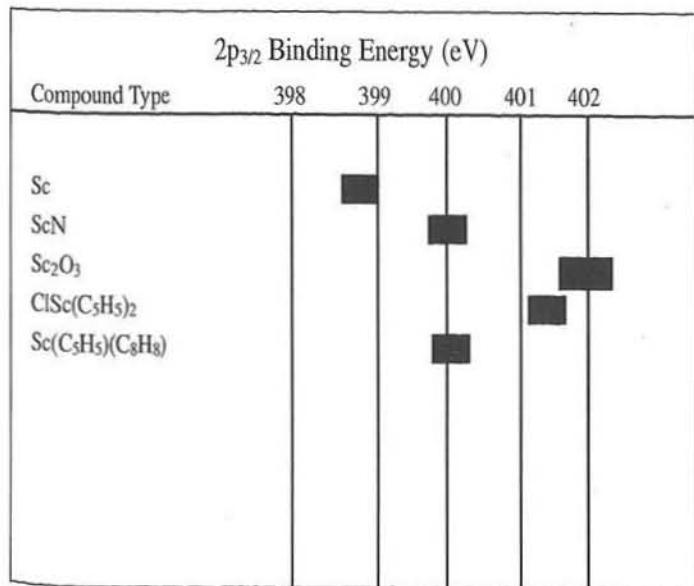
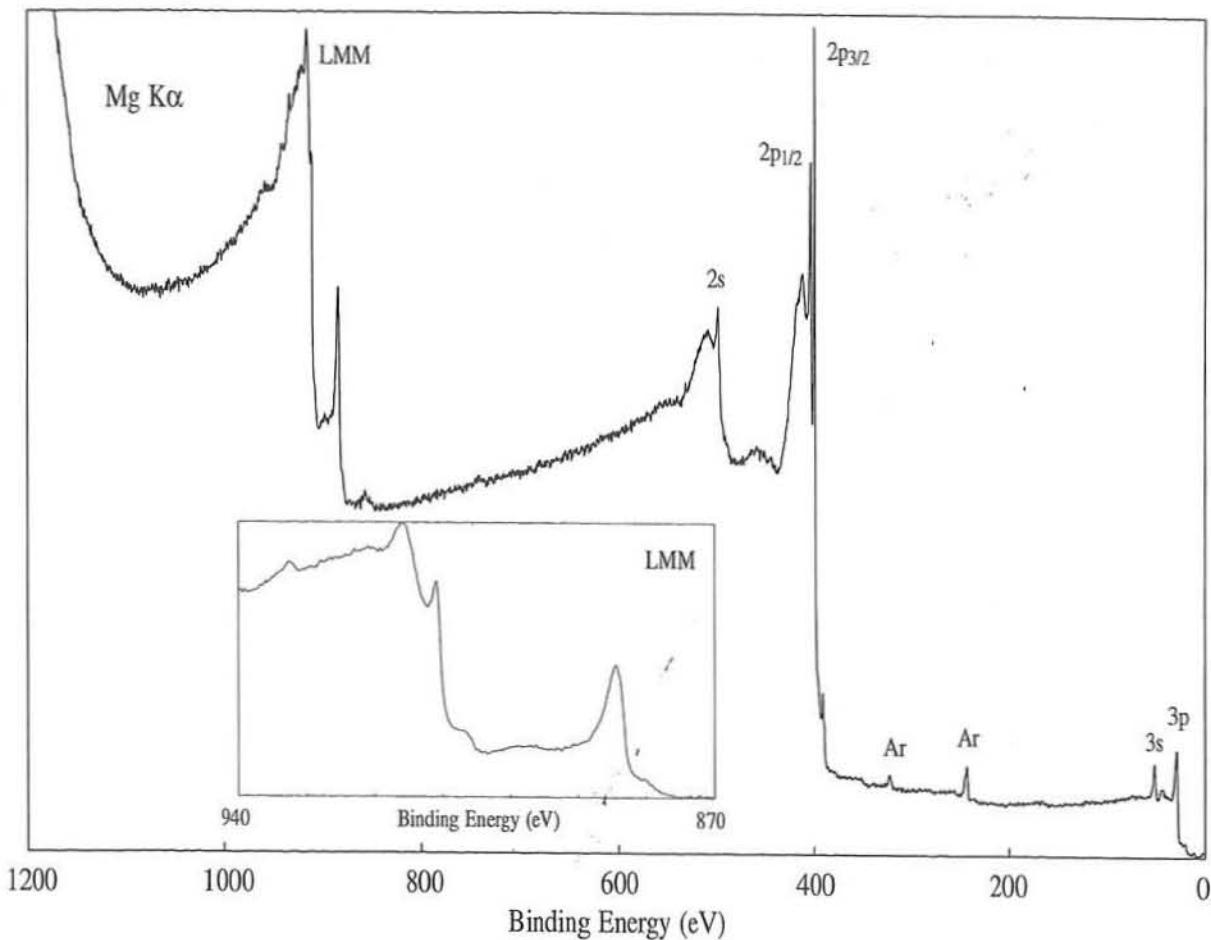
Photoelectron Lines

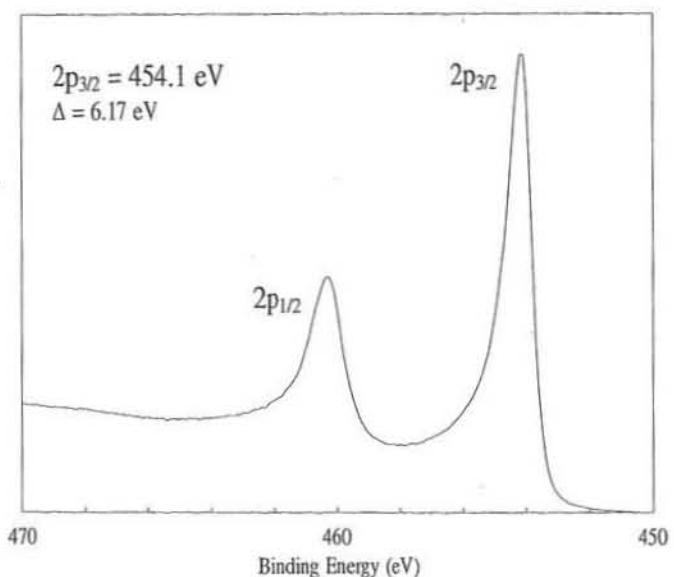
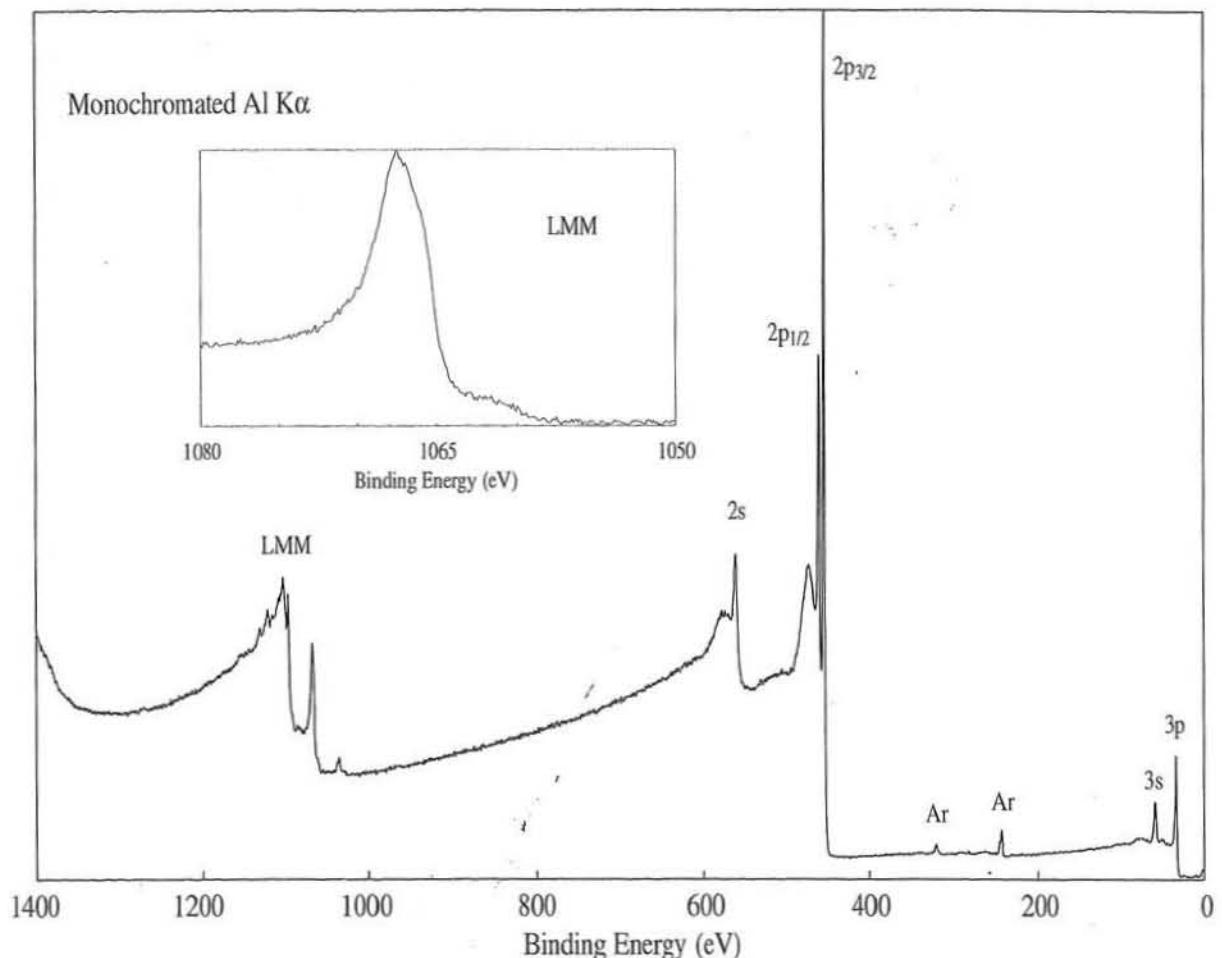
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p
499	404	399	51	29

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Auger Lines

LM <sub>23</sub> M <sub>23</sub>	L <sub>3</sub> M <sub>23</sub> M <sub>45</sub> ( <sup>1</sup> P)
1149	1118 (Al)
916	885 (Mg)

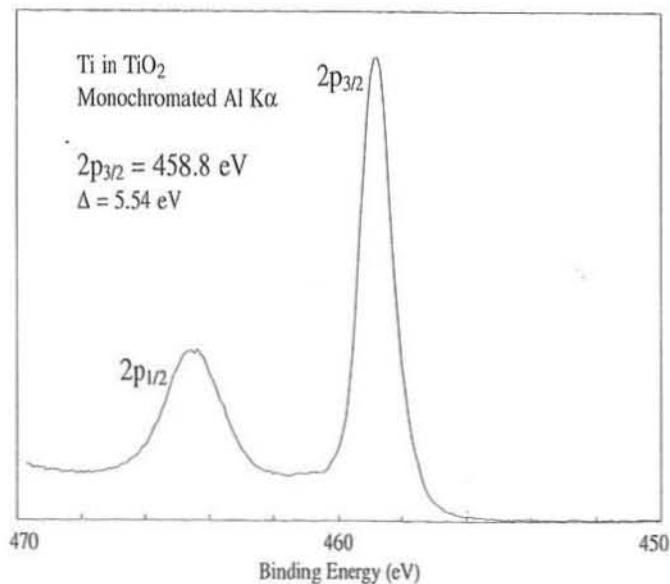
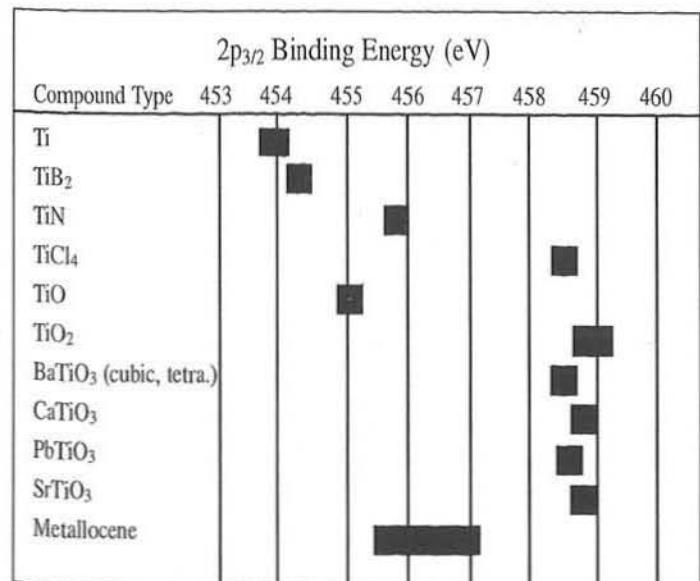
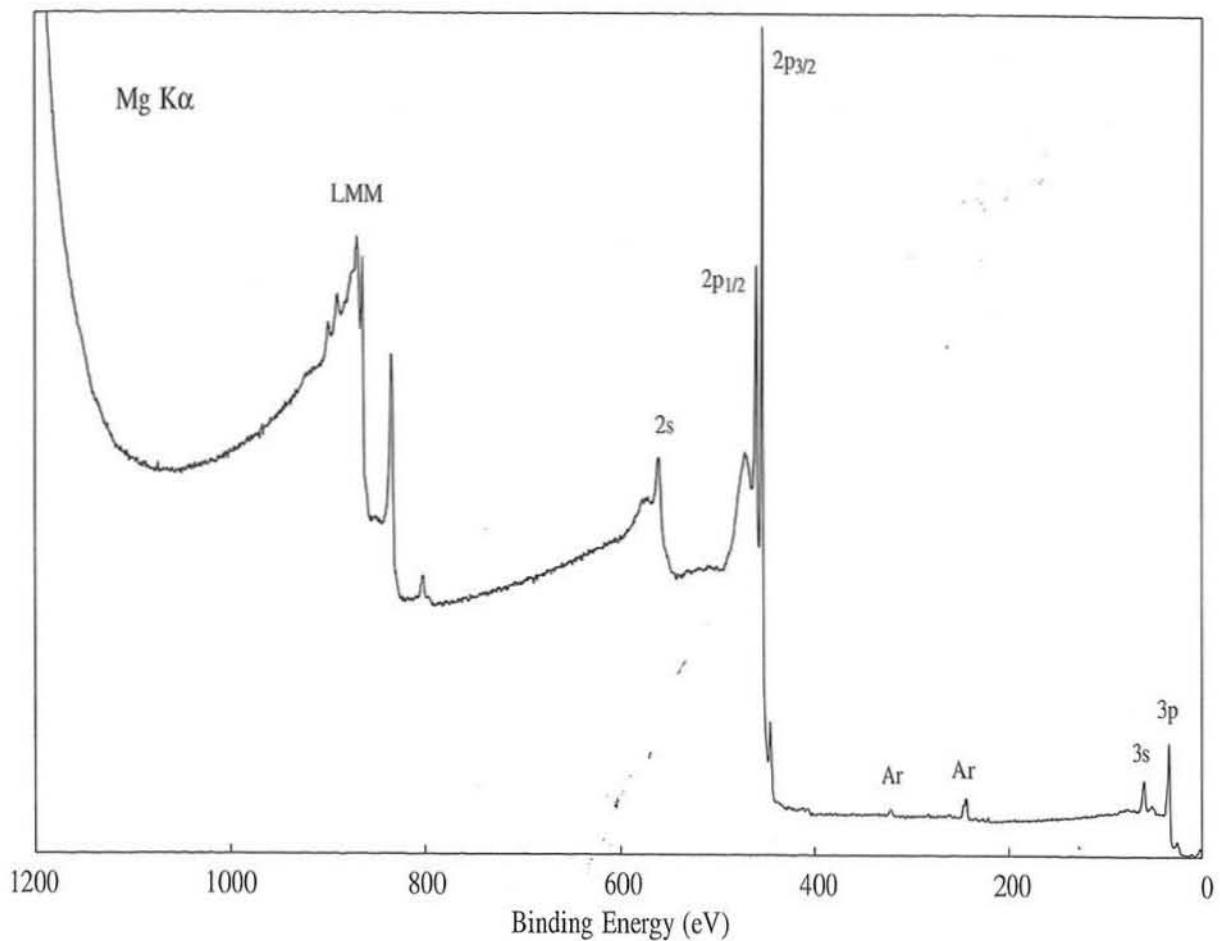


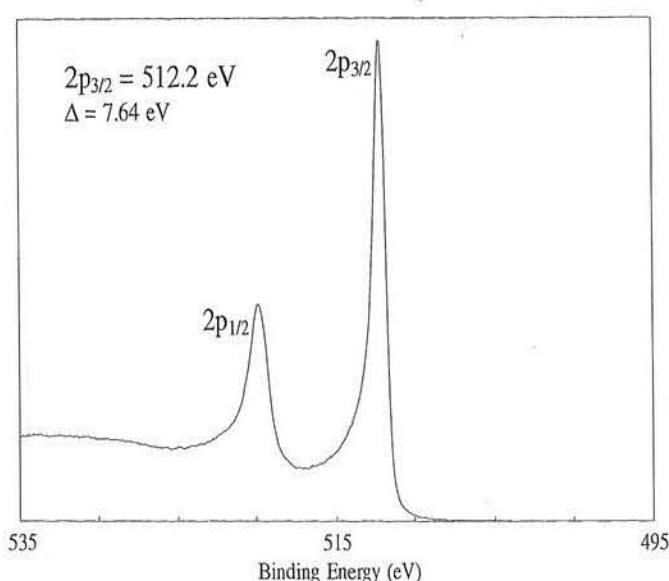
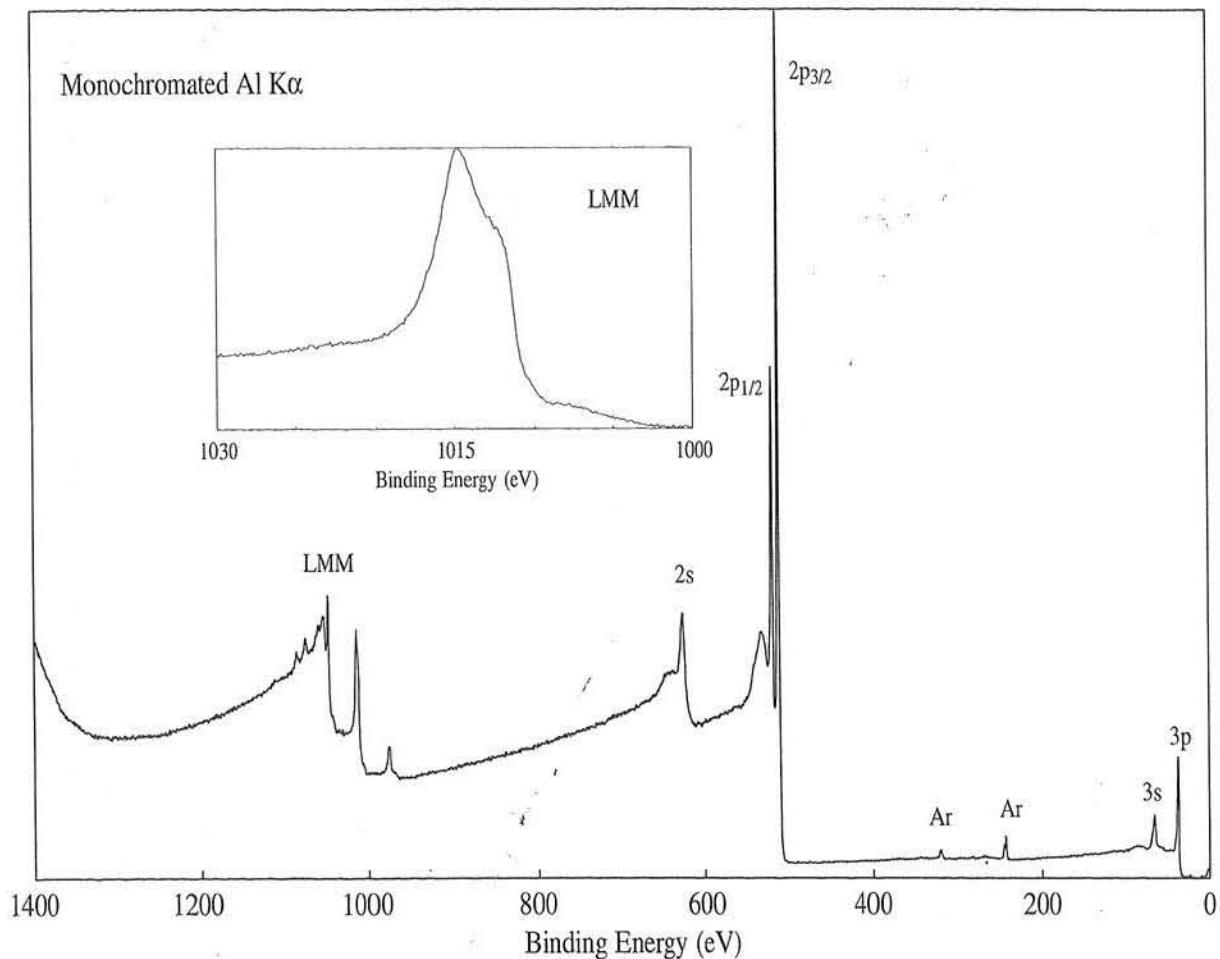


Line Positions (eV)				
<u>Photoelectron Lines</u>				
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p
561	460	454	59	33

<u>Auger Lines</u>				
LM <sub>23</sub> M <sub>23</sub>				L <sub>3</sub> M <sub>23</sub> M <sub>45</sub> (^1P)
1098		1068	(Al)	
865		835	(Mg)	





Line Positions (eV)

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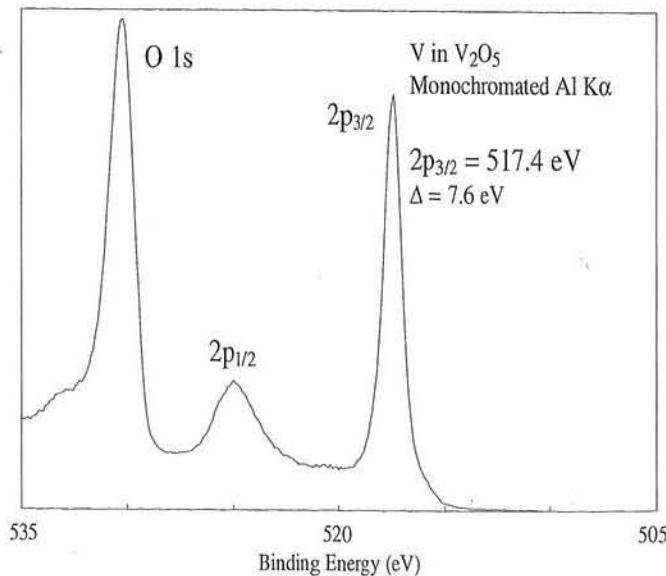
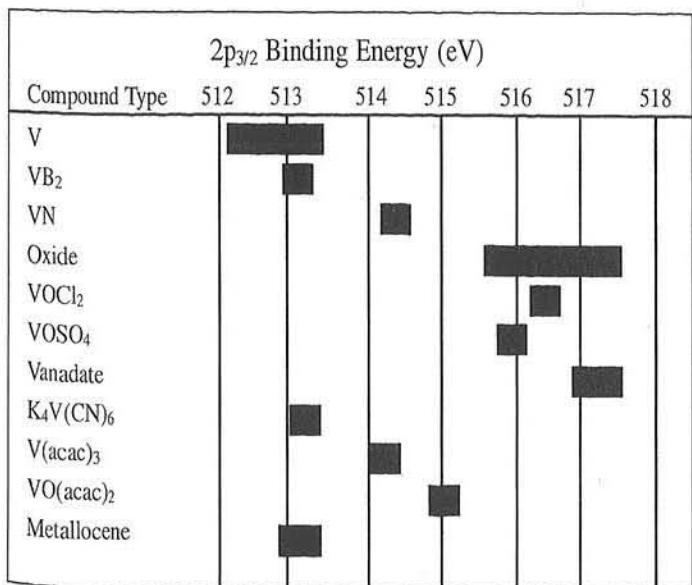
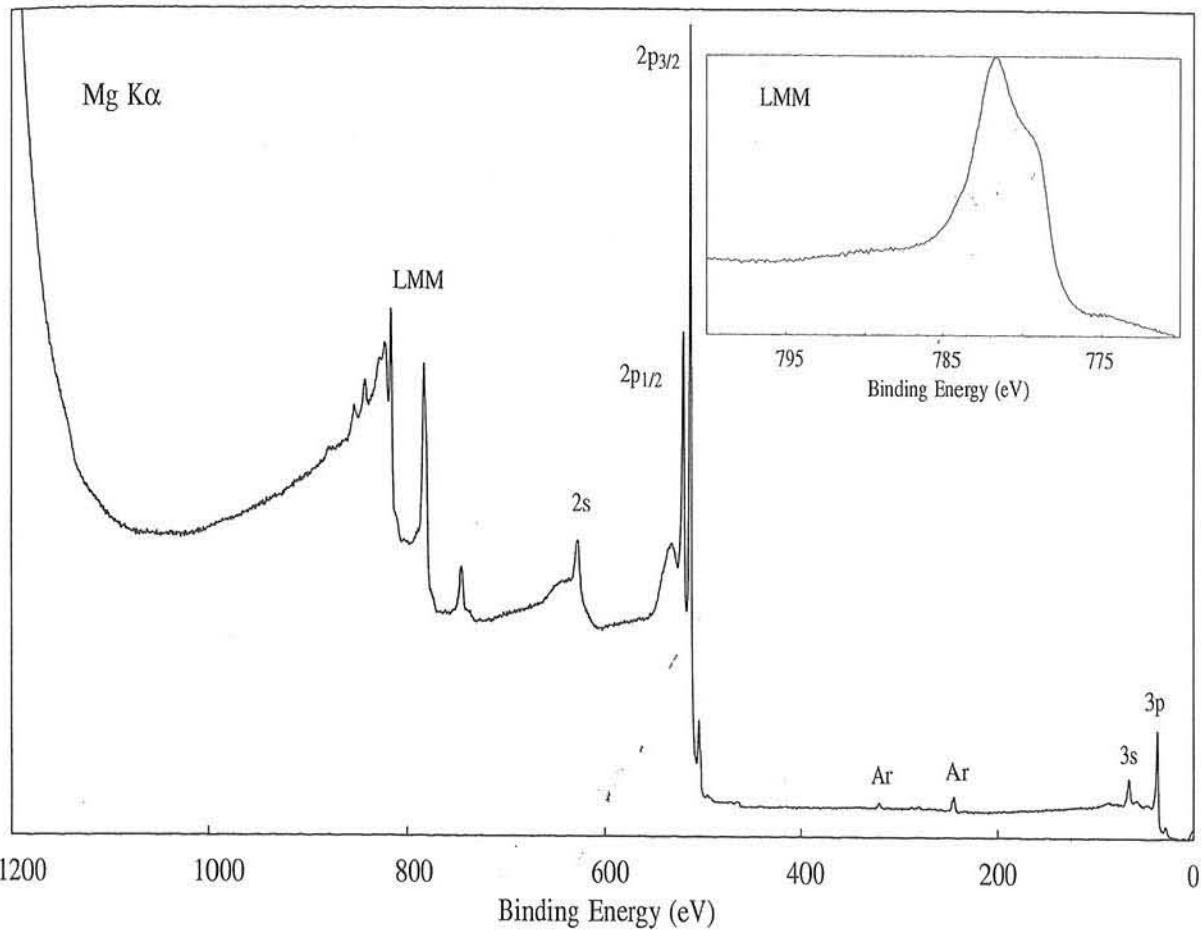
Photoelectron Lines

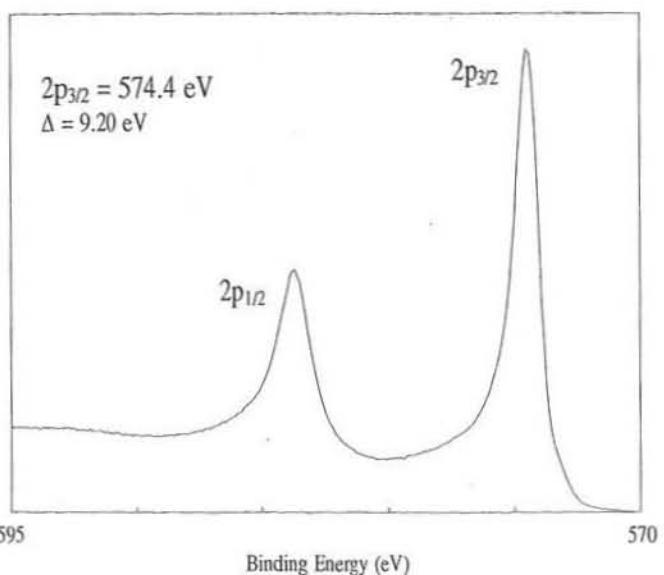
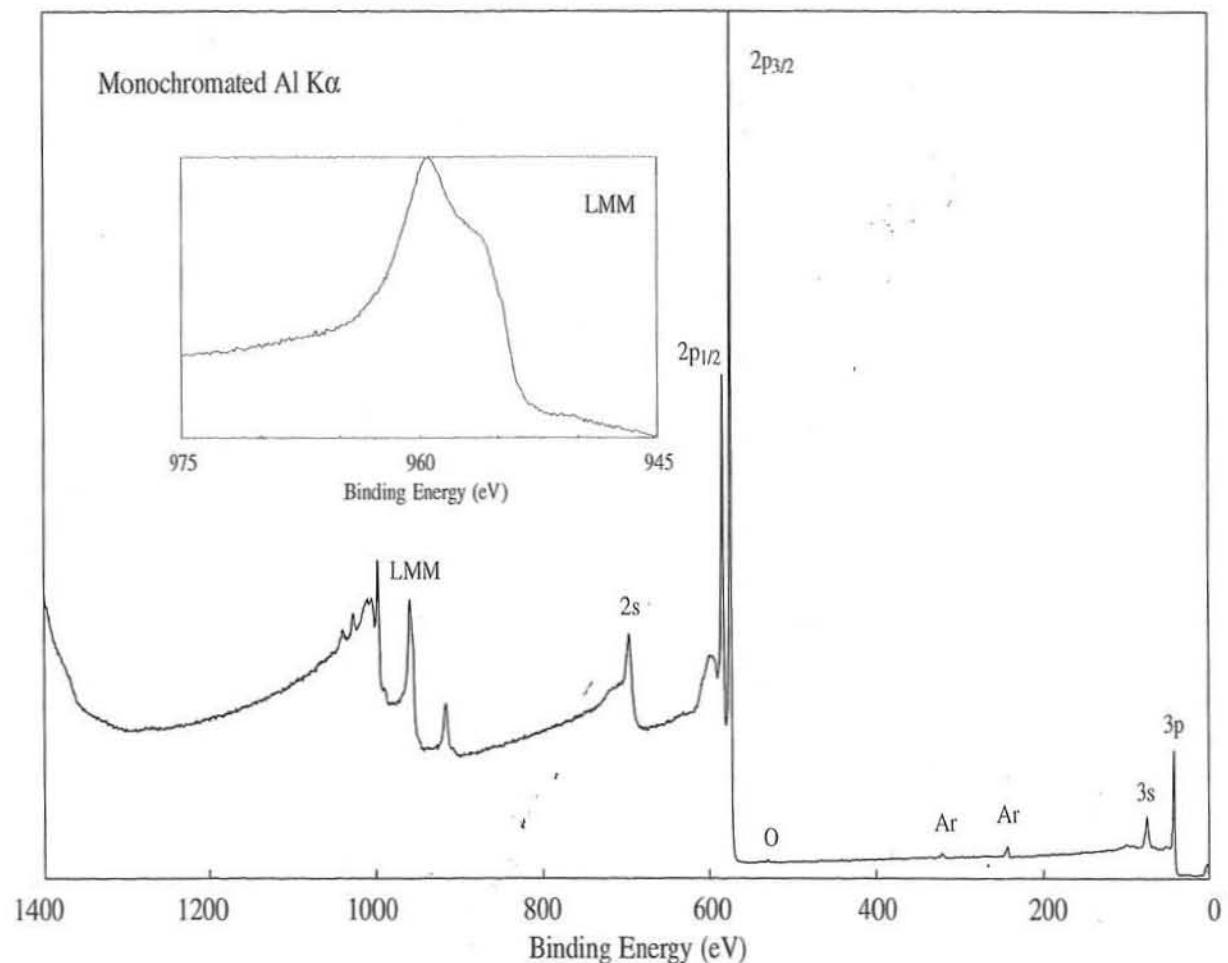
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p
627	520	512	66	37

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Auger Lines

L <sub>23</sub> M <sub>23</sub> M <sub>23</sub>	L <sub>3</sub> M <sub>23</sub> M <sub>45</sub> (P)	L <sub>3</sub> M <sub>45</sub> M <sub>45</sub>
1048	1014	977 (Al)
815	781	744 (Mg)





Line Positions (eV)

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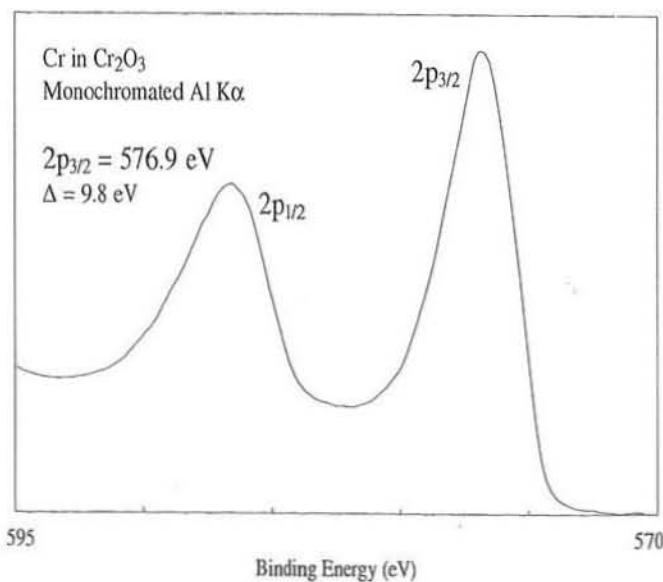
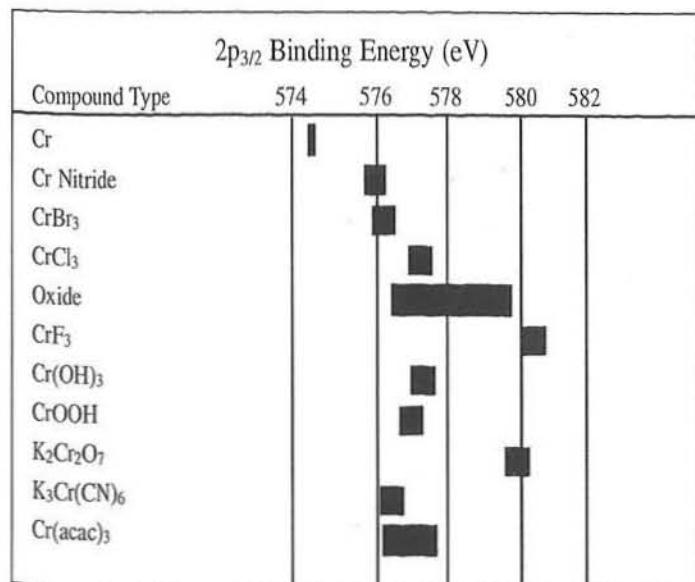
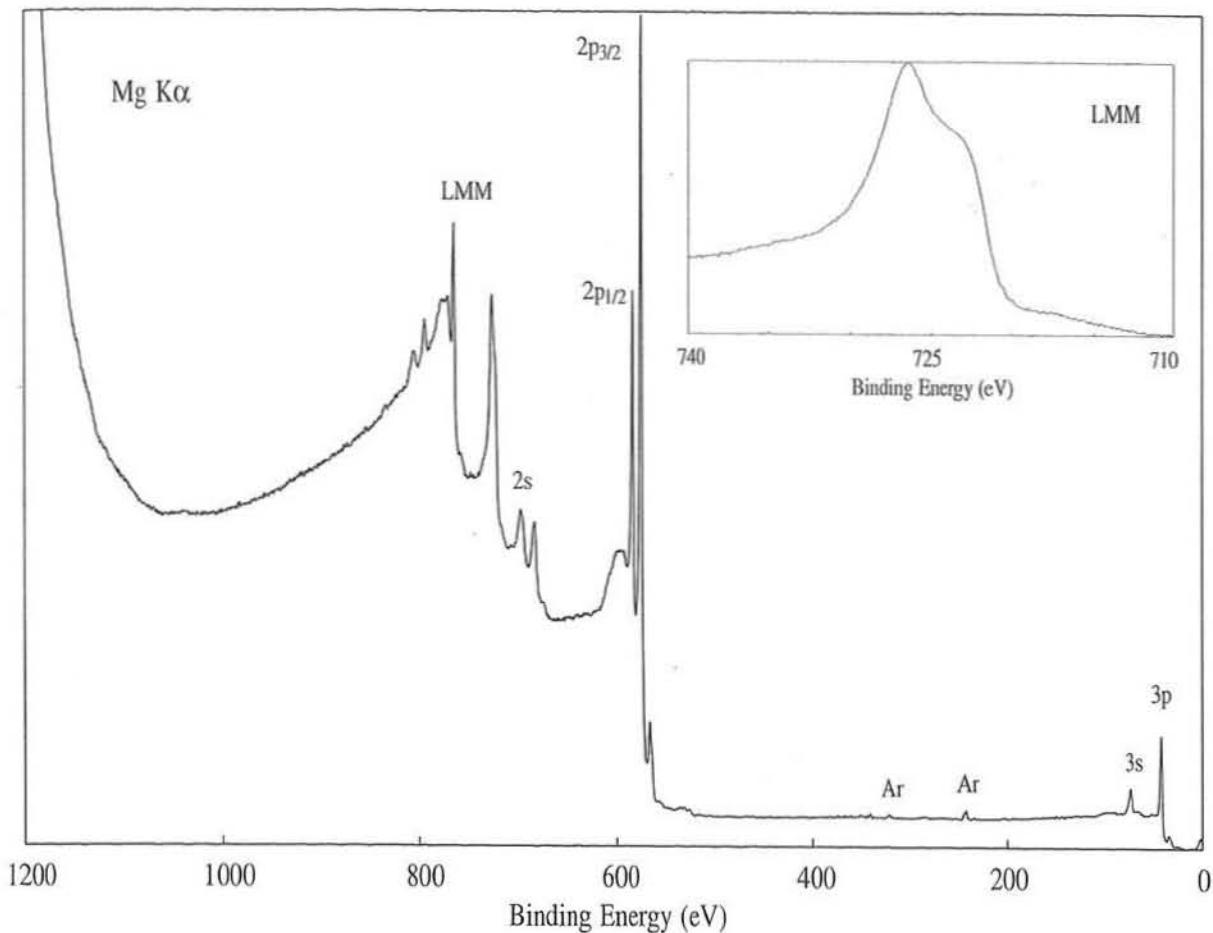
Photoelectron Lines

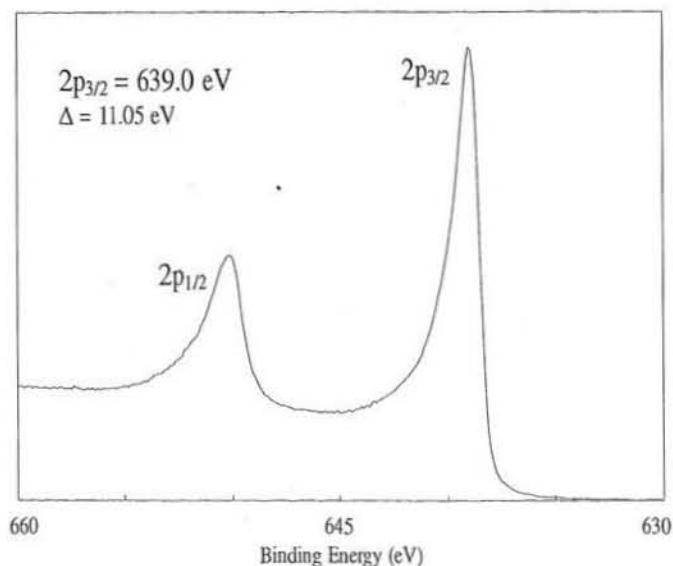
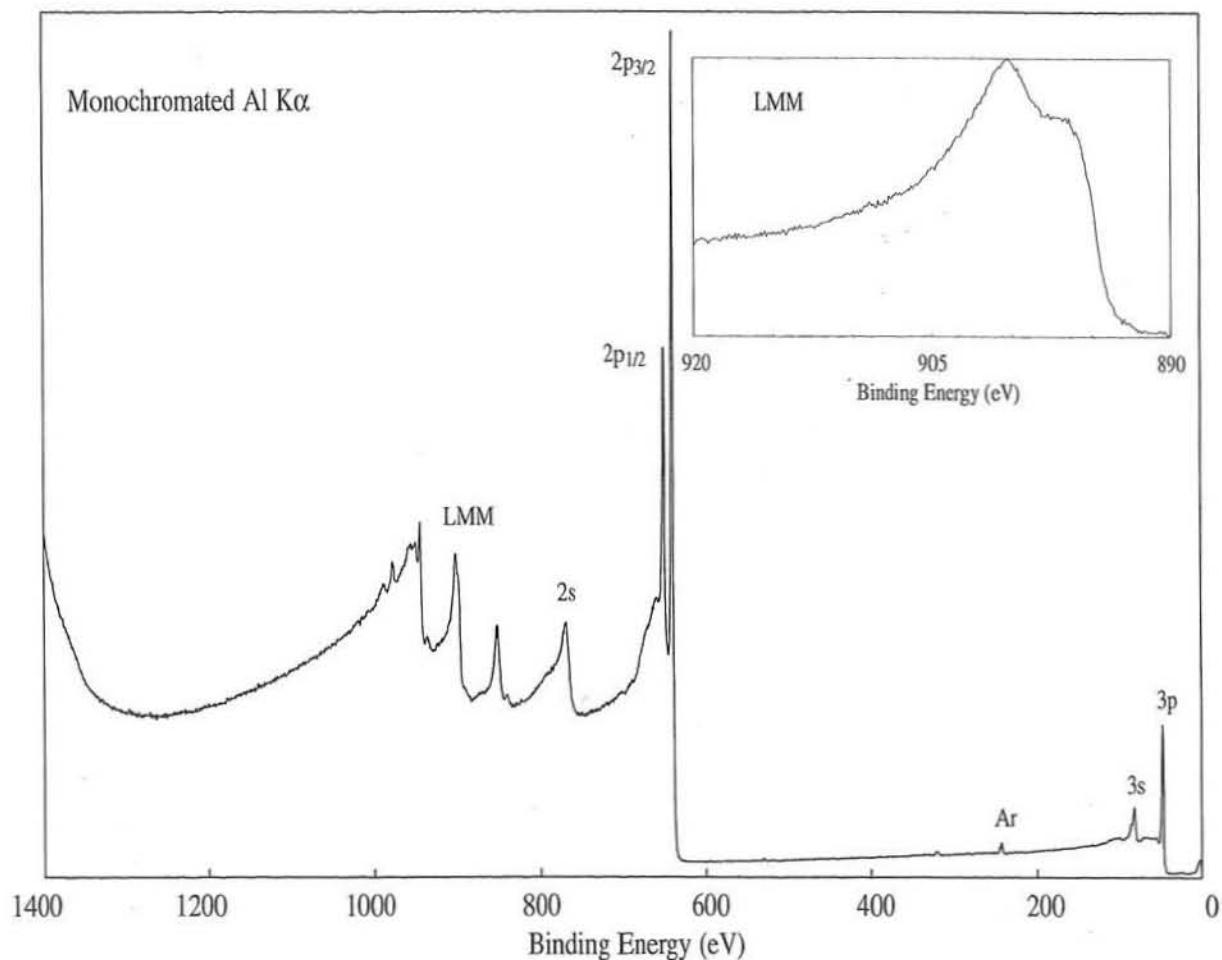
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p
696	583	574	75	43

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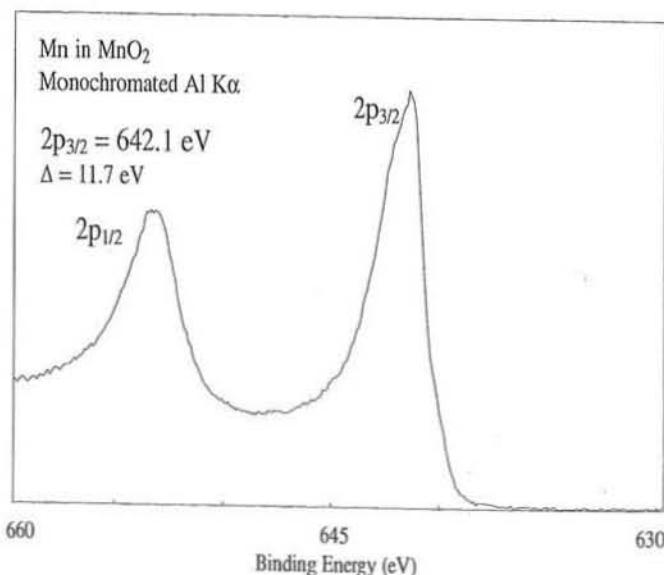
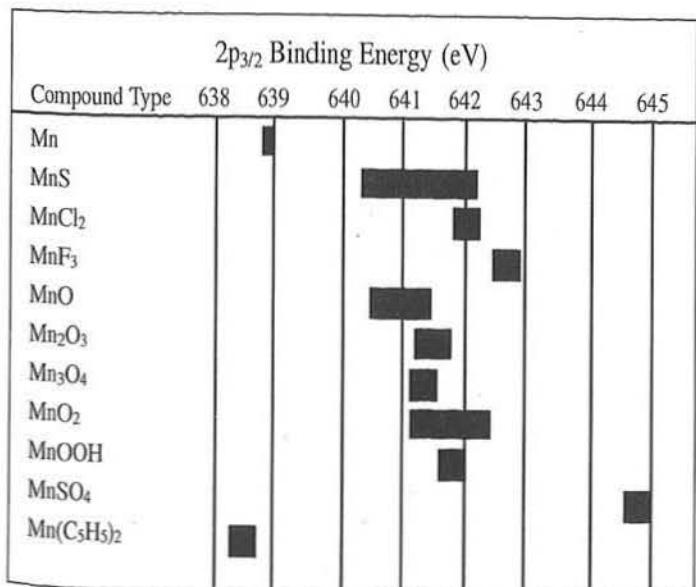
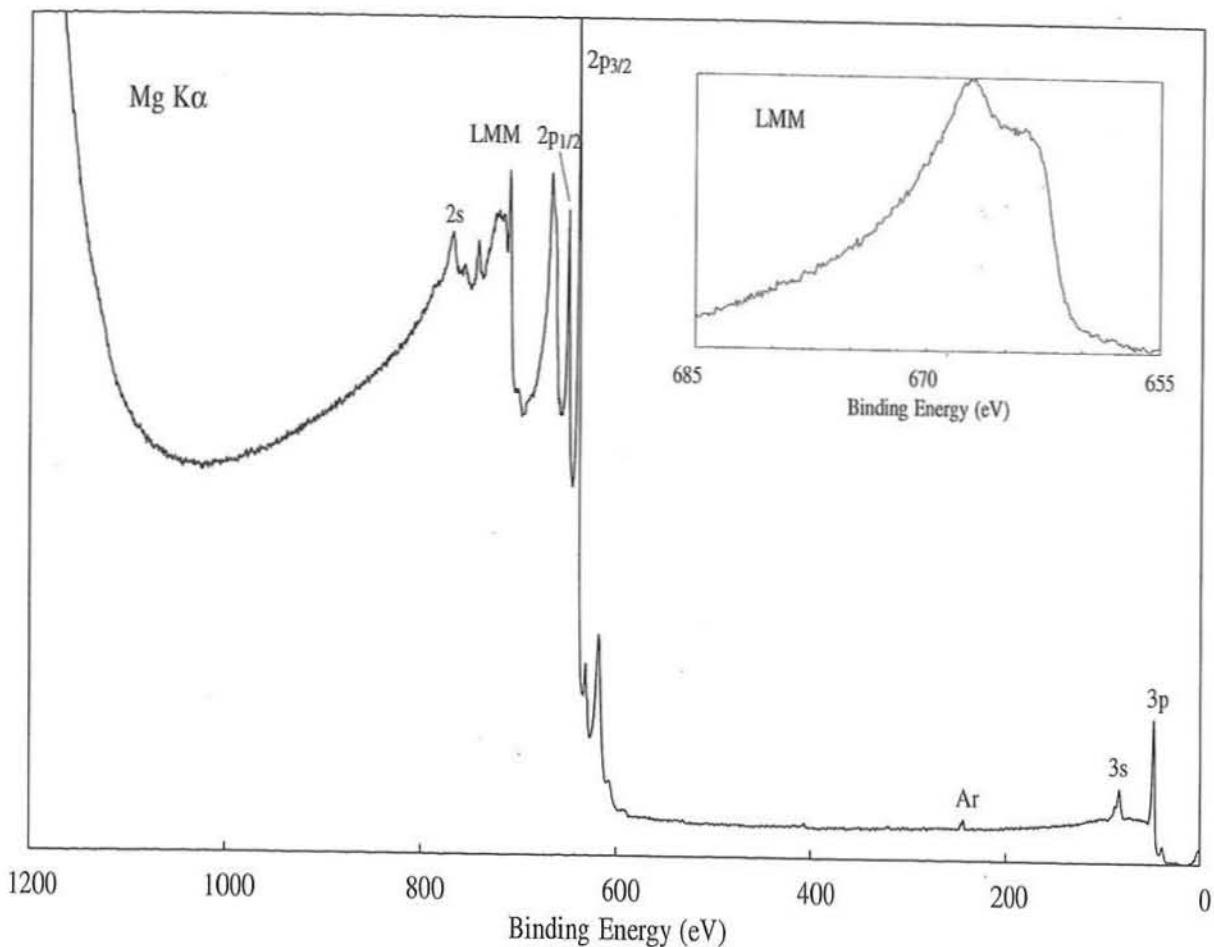
Auger Lines

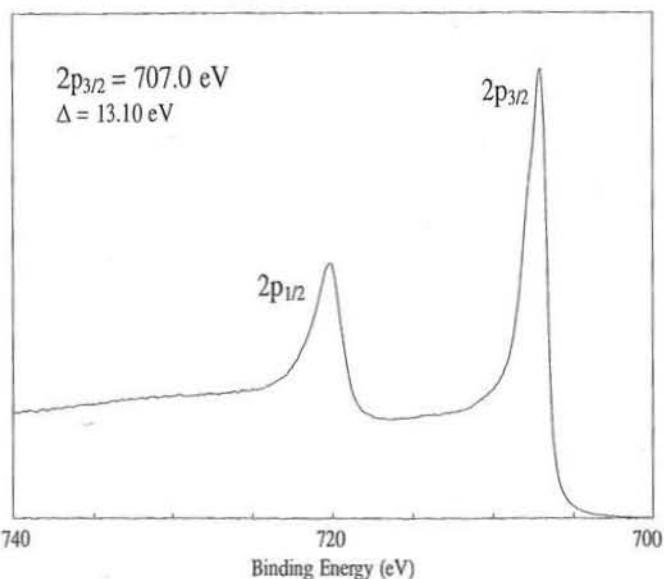
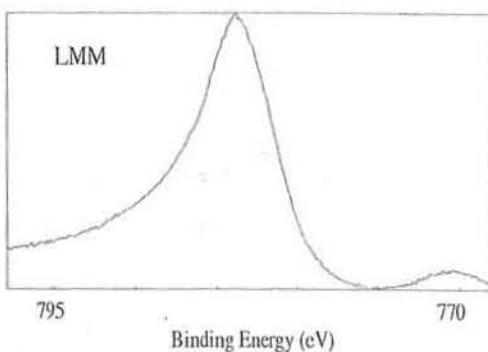
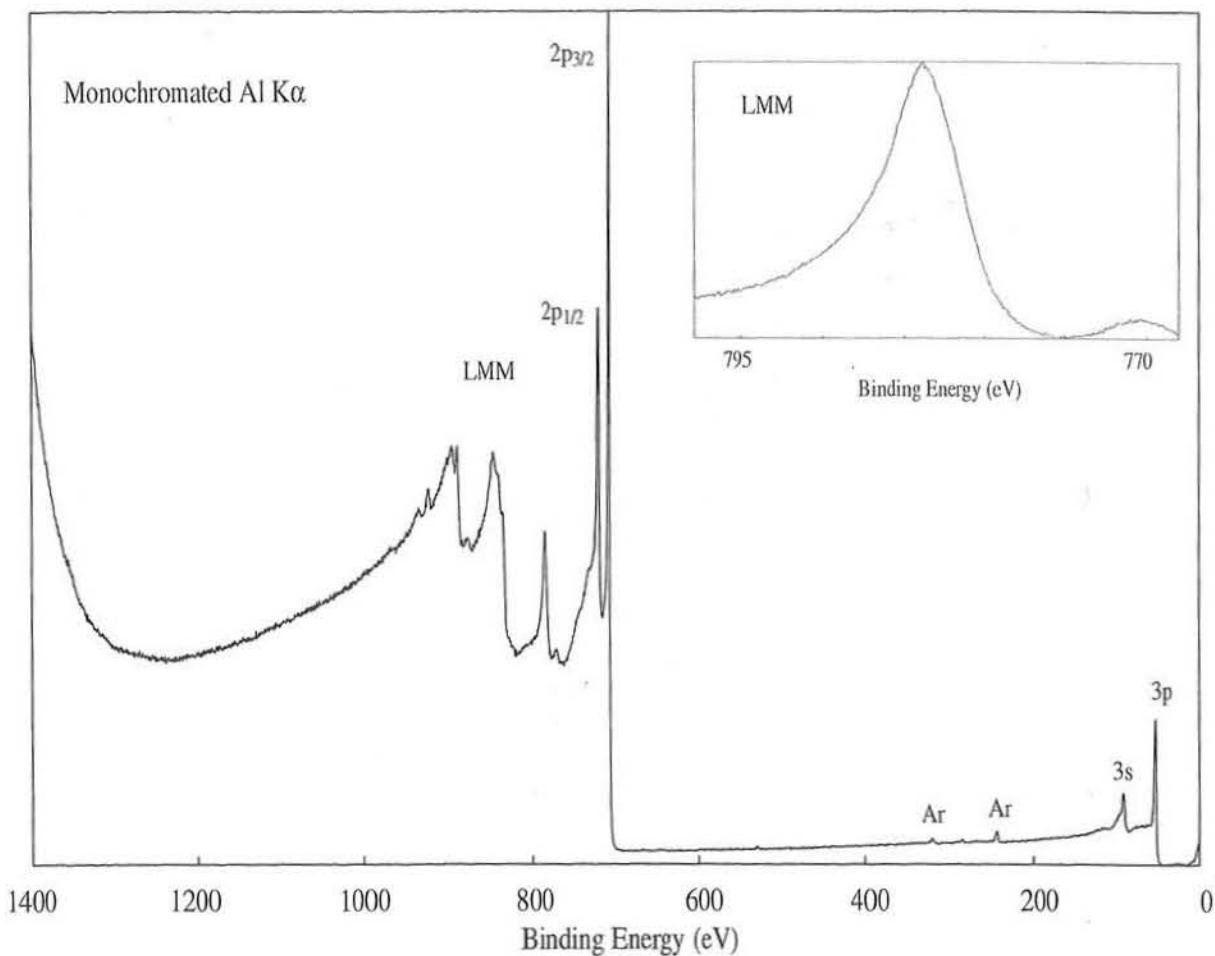
L <sub>23</sub> M <sub>23</sub> M <sub>23</sub>	L <sub>3</sub> M <sub>23</sub> M <sub>45</sub> (^P)	L <sub>3</sub> M <sub>45</sub> M <sub>45</sub>
997	959	917 (Al)
764	726	684 (Mg)





Line Positions (eV)				
Photoelectron Lines				
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p
769	650	639	83	48
Auger Lines				
L <sub>23</sub> M <sub>23</sub> M <sub>23</sub>	L <sub>3</sub> M <sub>23</sub> M <sub>45</sub>	L <sub>3</sub> M <sub>45</sub> M <sub>45</sub>		
944	900	852	(Al)	
711	667	619	(Mg)	





Line Positions (eV)

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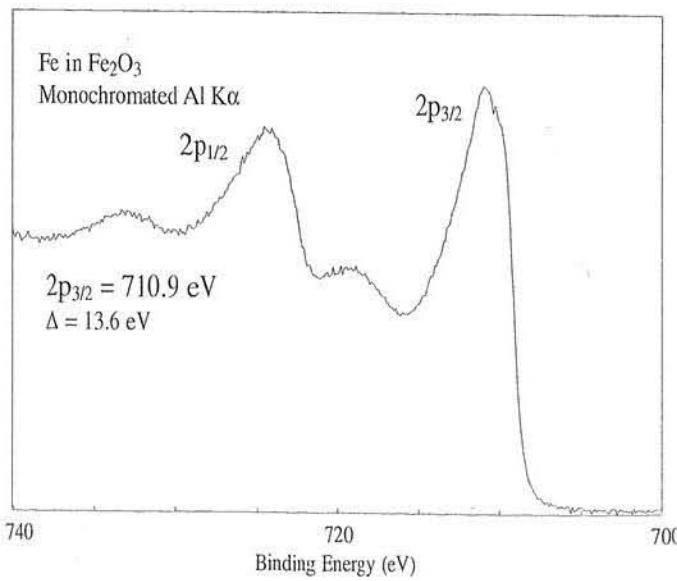
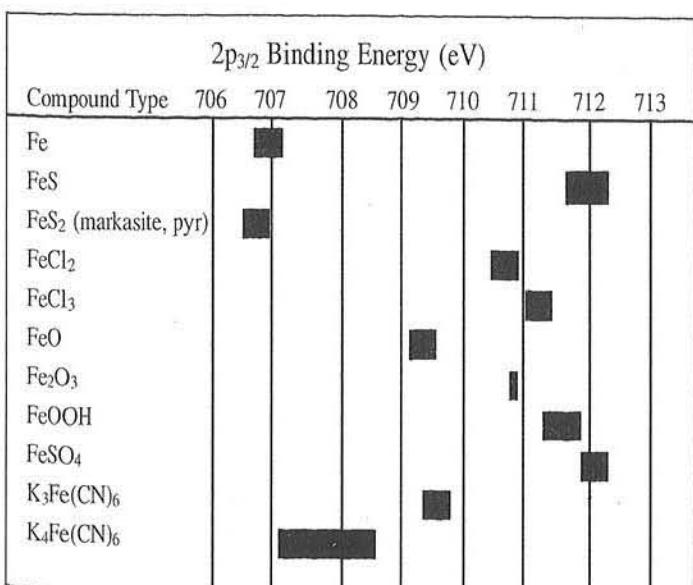
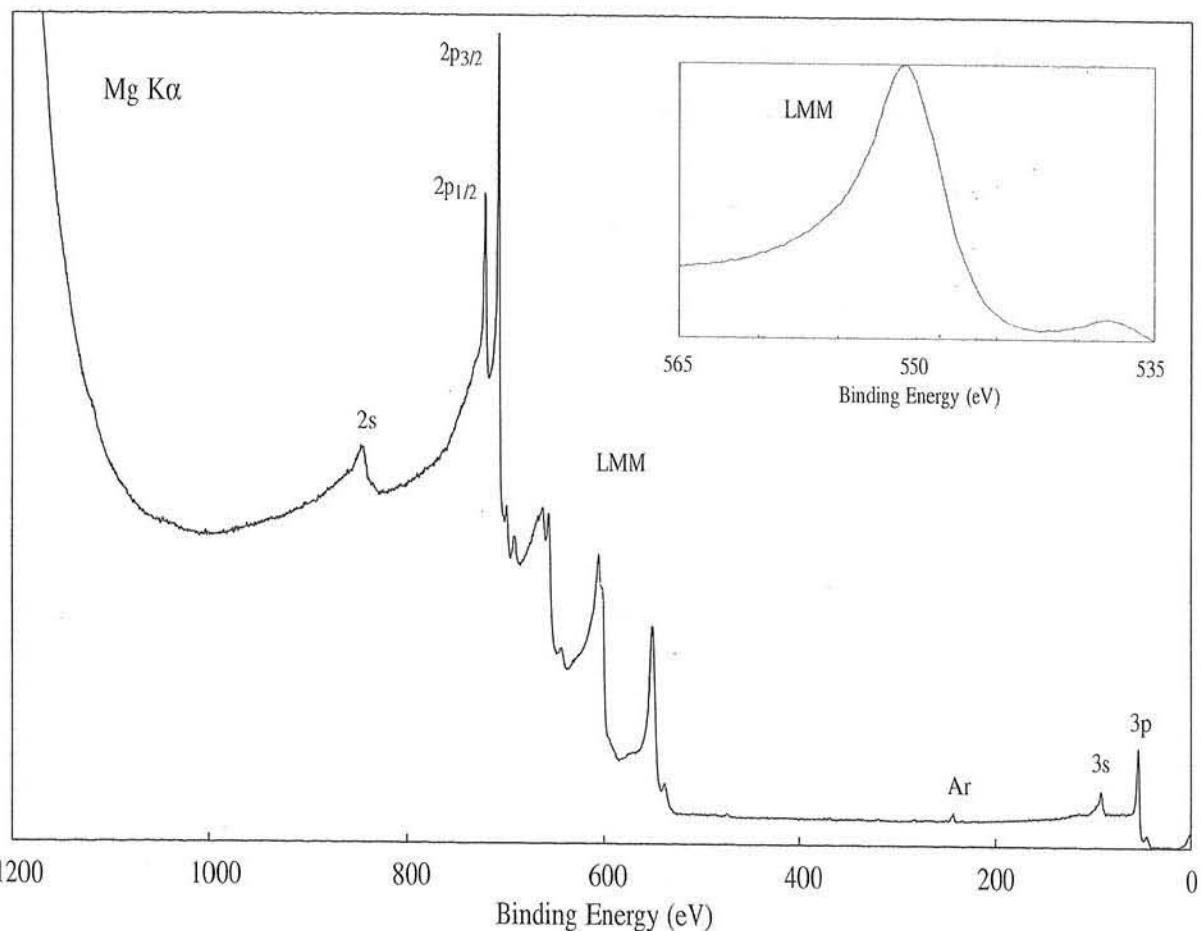
Photoelectron Lines

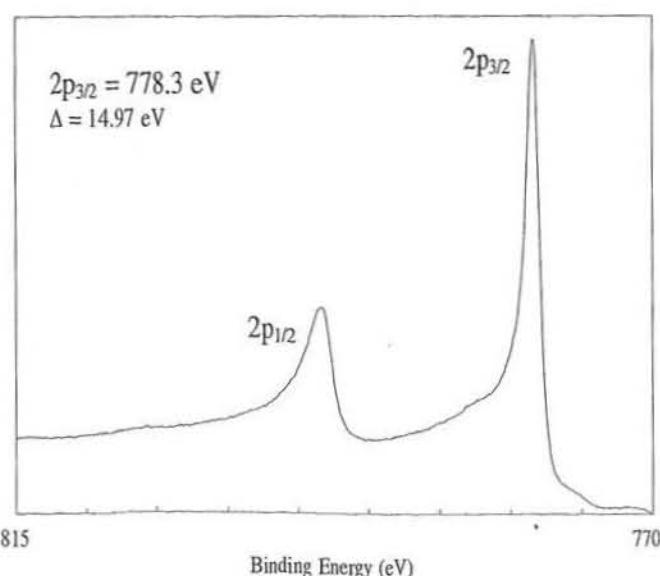
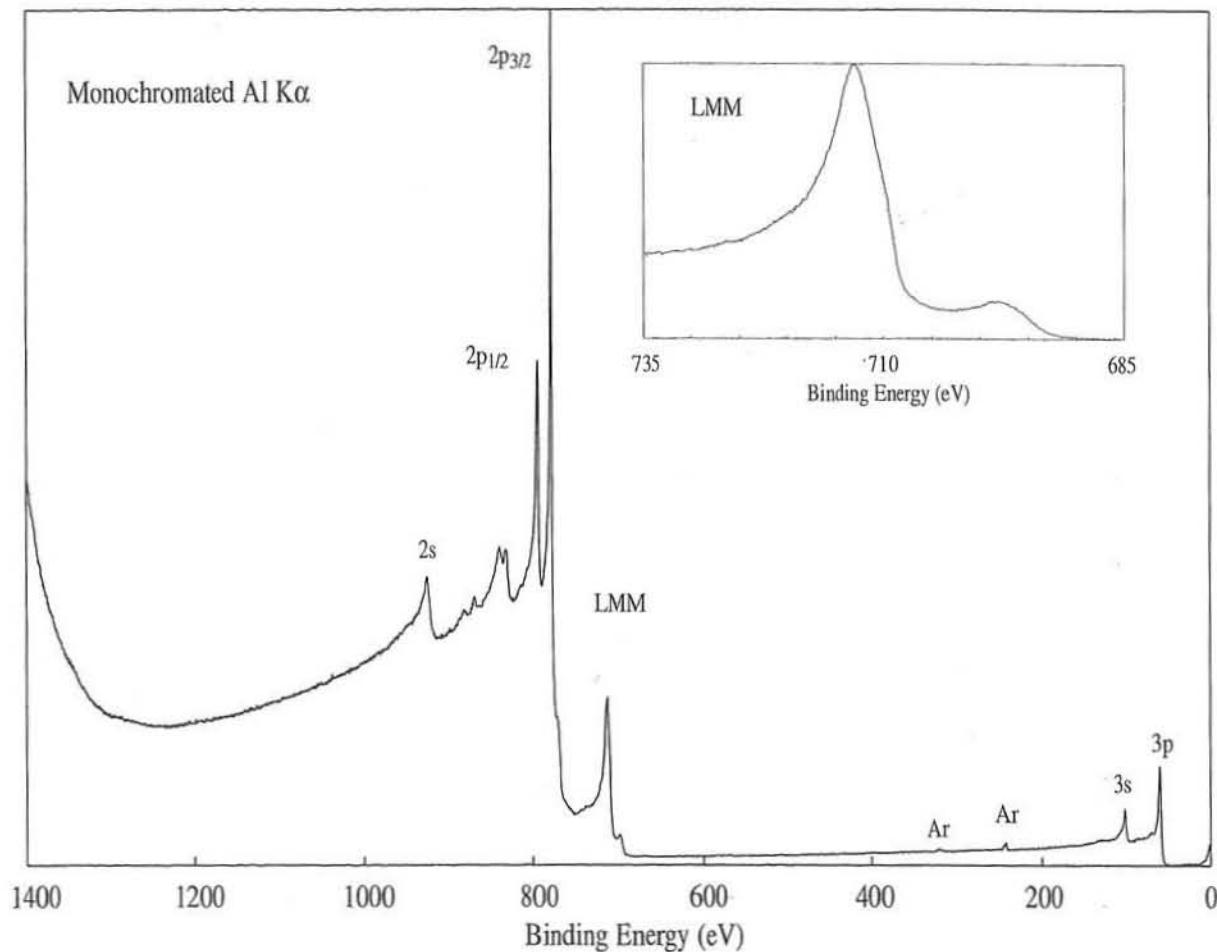
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p
845	720	707	92	53

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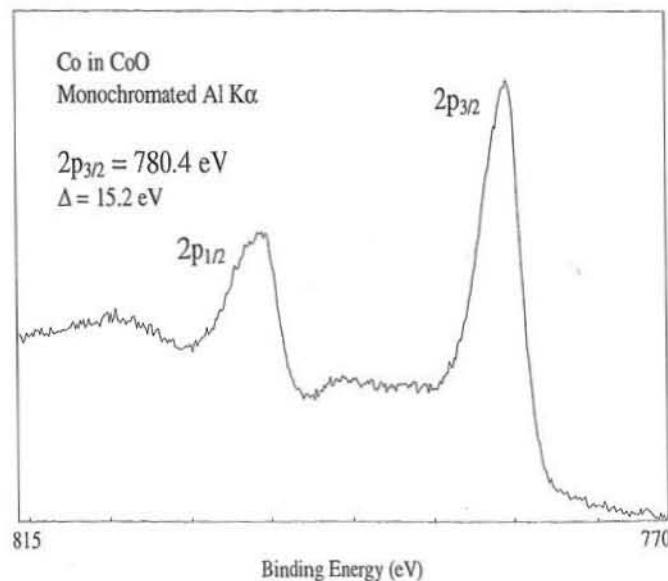
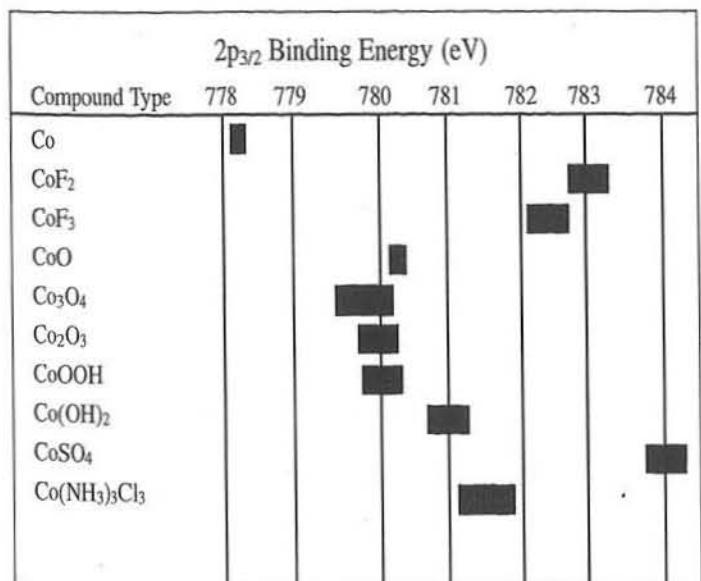
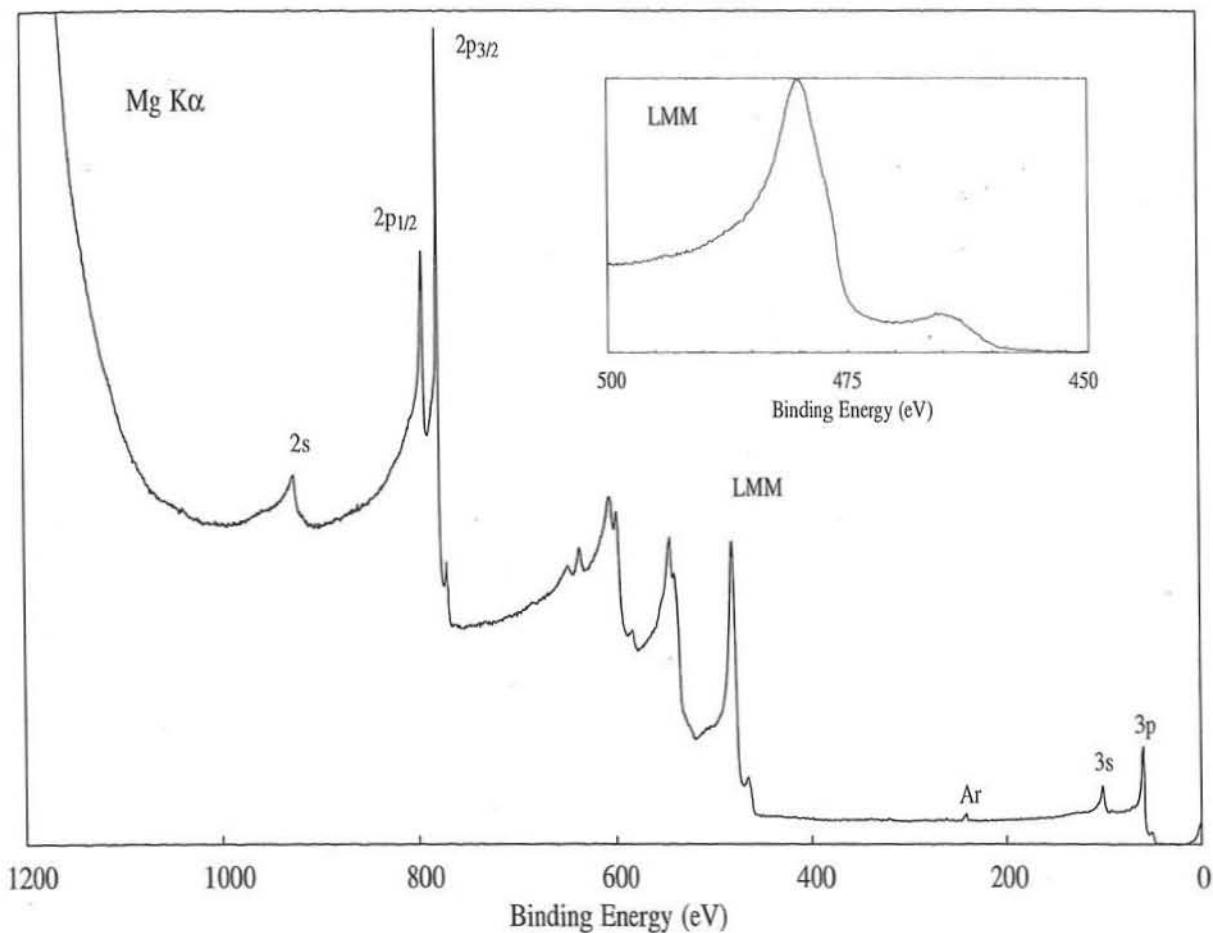
Auger Lines

LM <sub>23</sub> M <sub>23</sub>	L <sub>3</sub> M <sub>23</sub> M <sub>45</sub> ( <sup>1</sup> P)	L <sub>3</sub> M <sub>45</sub> M <sub>45</sub>
888	839	784 (Al)
655	606	551 (Mg)



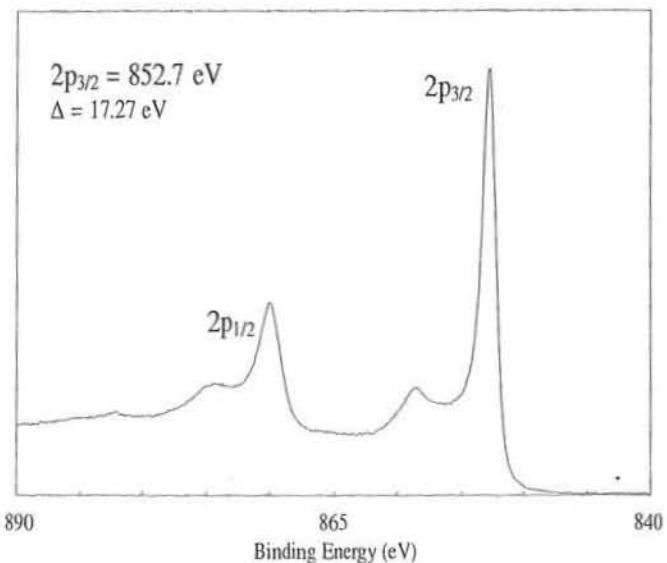
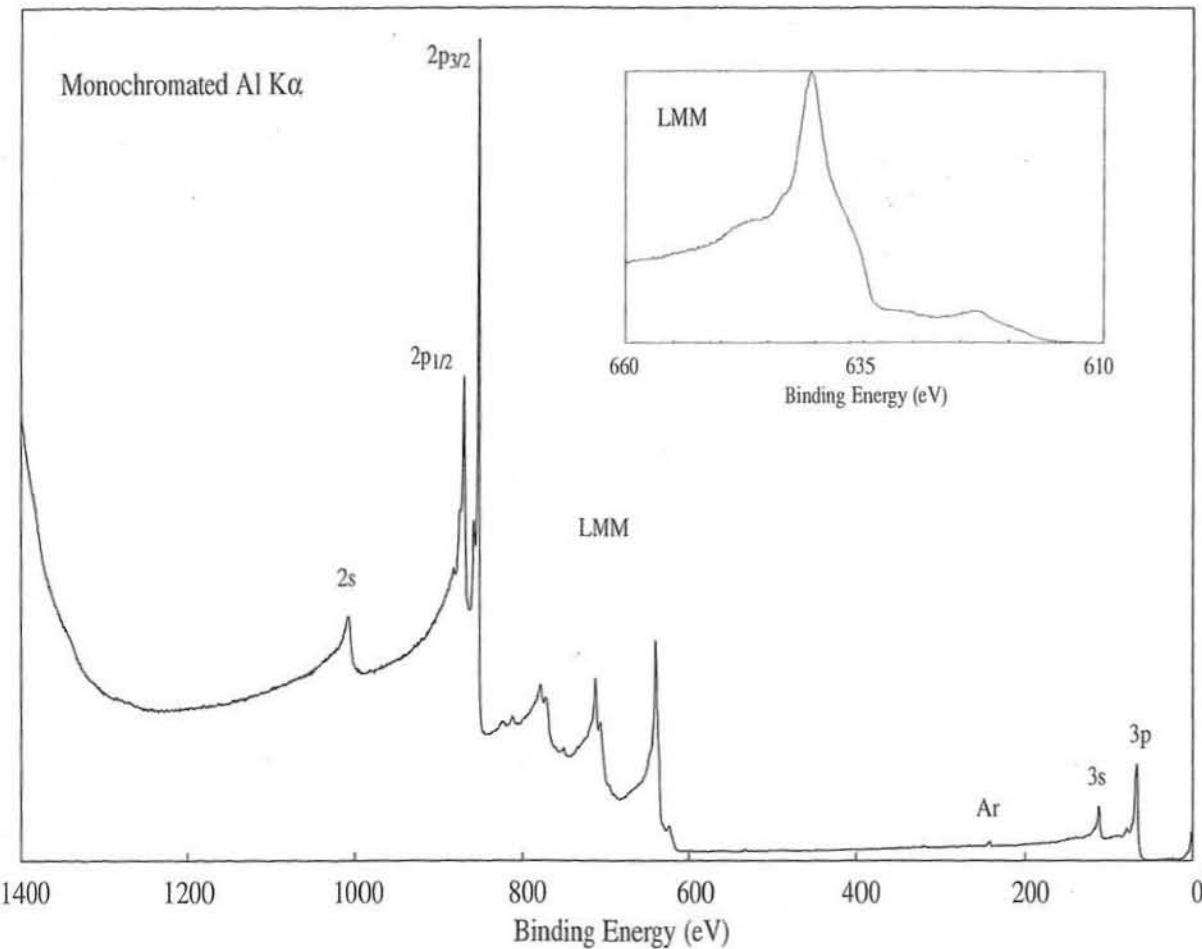


Line Positions (eV)				
<u>Photoelectron Lines</u>				
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p
925	793	778	101	60
<u>Auger Lines</u>				
L <sub>3</sub> M <sub>23</sub> M <sub>23</sub>	L <sub>2</sub> M <sub>23</sub> M <sub>23</sub>	L <sub>3</sub> M <sub>23</sub> M <sub>45</sub> (^1P)		
838	831	777	(Al)	
605	598	544	(Mg)	
L <sub>3</sub> M <sub>23</sub> M <sub>45</sub> (^3P)	L <sub>2</sub> M <sub>23</sub> M <sub>45</sub> (^1P)	L <sub>3</sub> M <sub>45</sub> M <sub>45</sub>		
771	713	698	(Al)	
538	480	465	(Mg)	

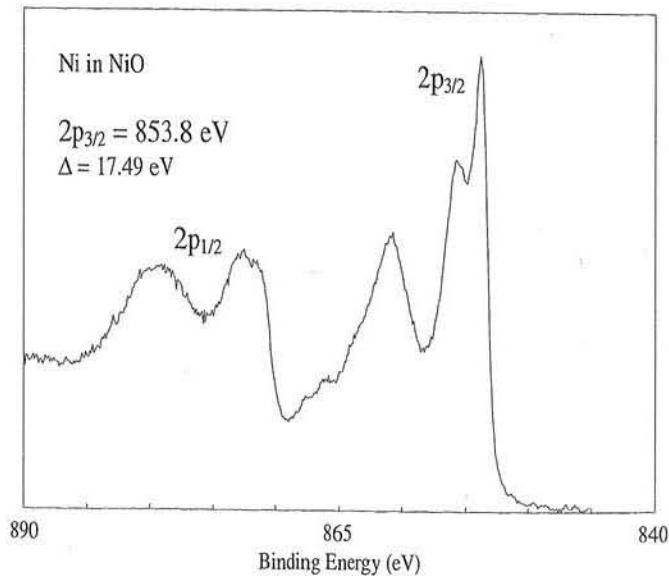
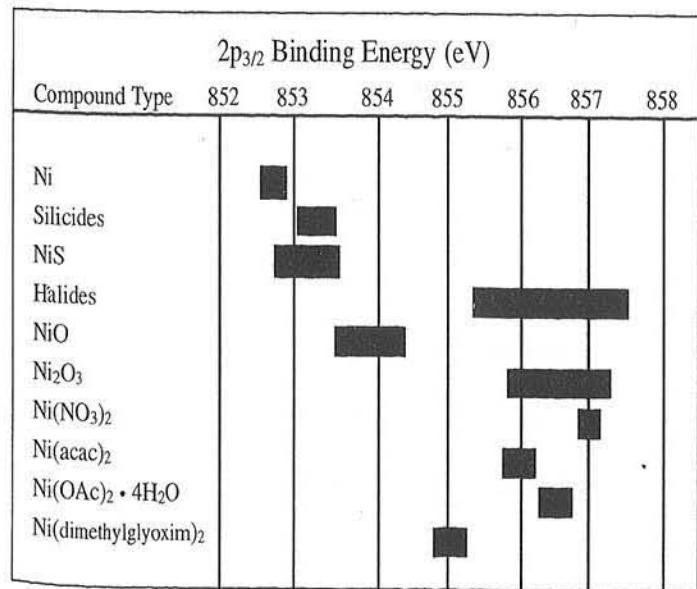
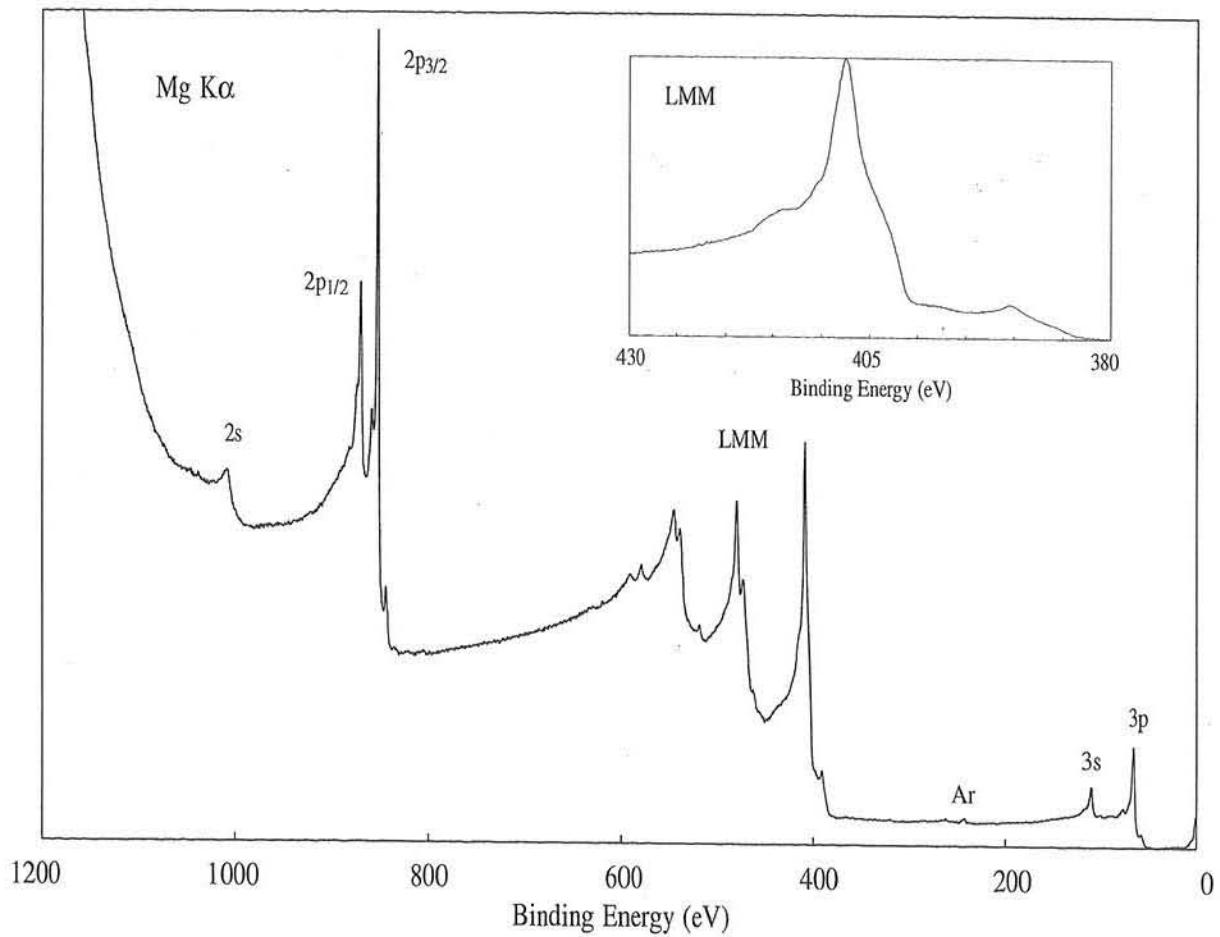


Nickel      Ni  
Atomic Number 28

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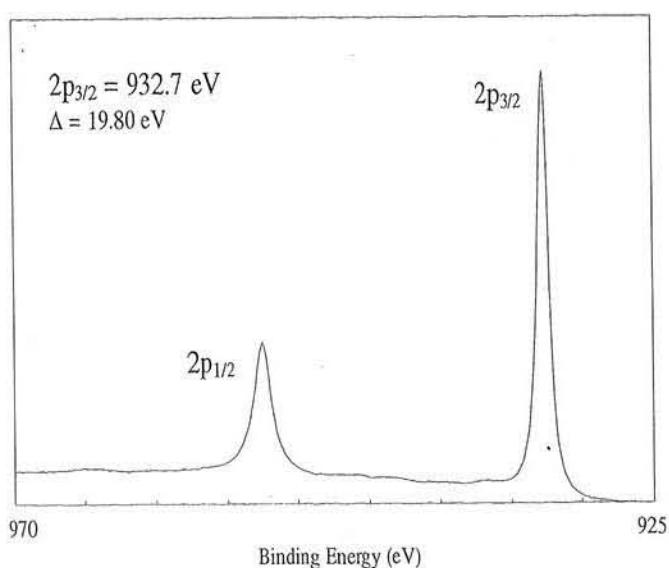
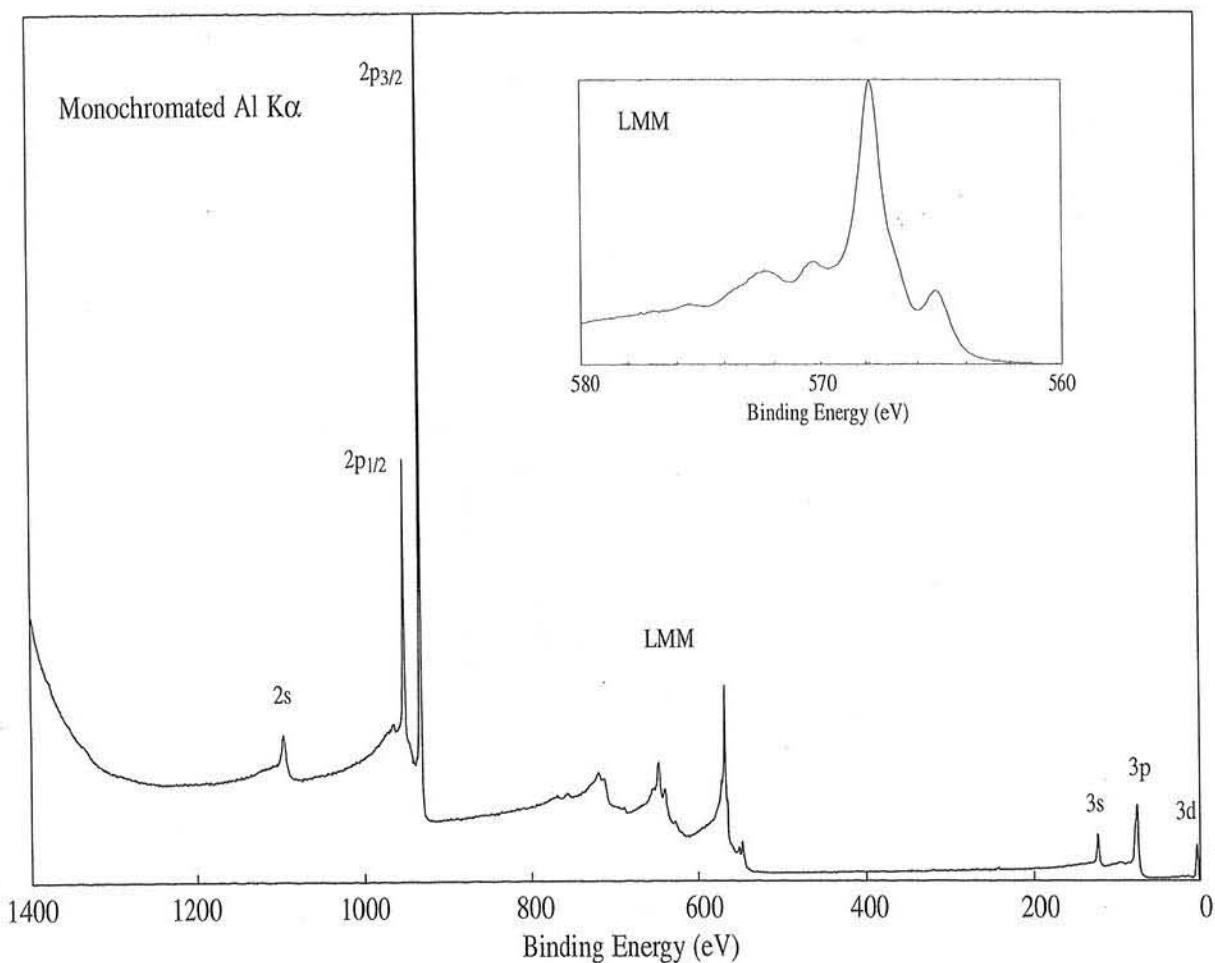


Line Positions (eV)				
Photoelectron Lines				
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p
1009	870	853	111	67
Auger Lines				
$L_3M_{23}M_{23}$		$L_2M_{23}M_{23}$		$L_3M_{23}M_{45}$ ( $^1P$ )
778		772		712
545		539		479
$L_3M_{23}M_{45}$ ( $^3P$ )		$L_2M_{23}M_{45}$ ( $^1P$ )		$L_3M_{45}M_{45}$
706		641		624 (Al)
473		408		391 (Mg)



**Copper Cu**  
Atomic Number 29

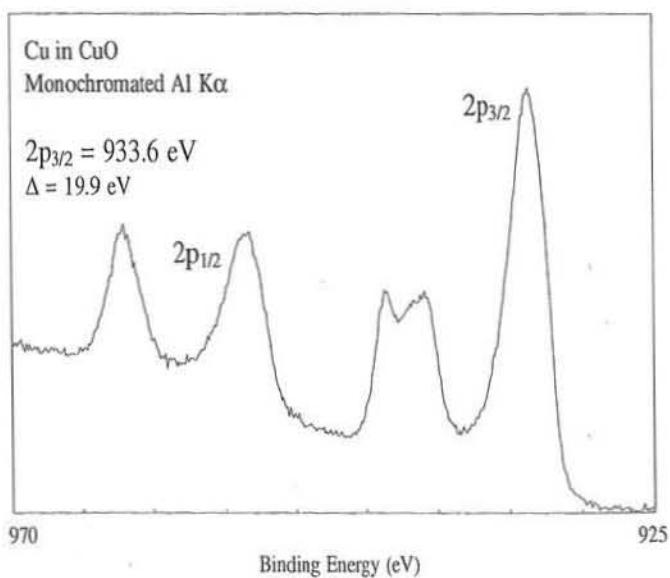
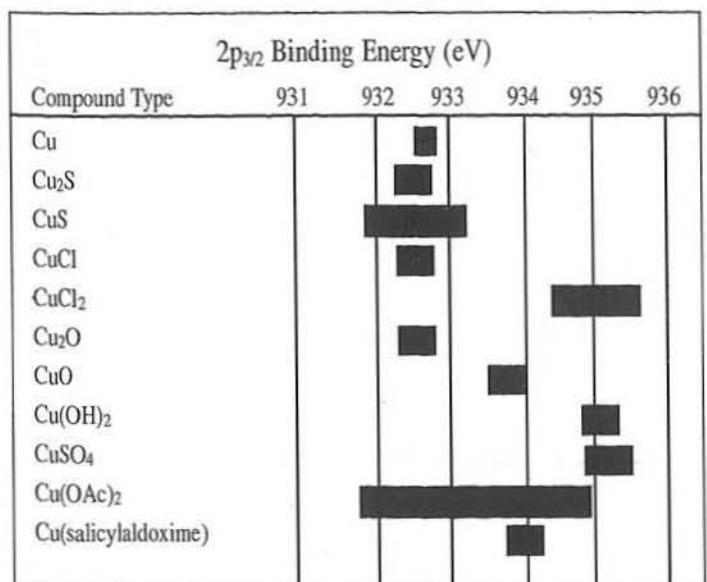
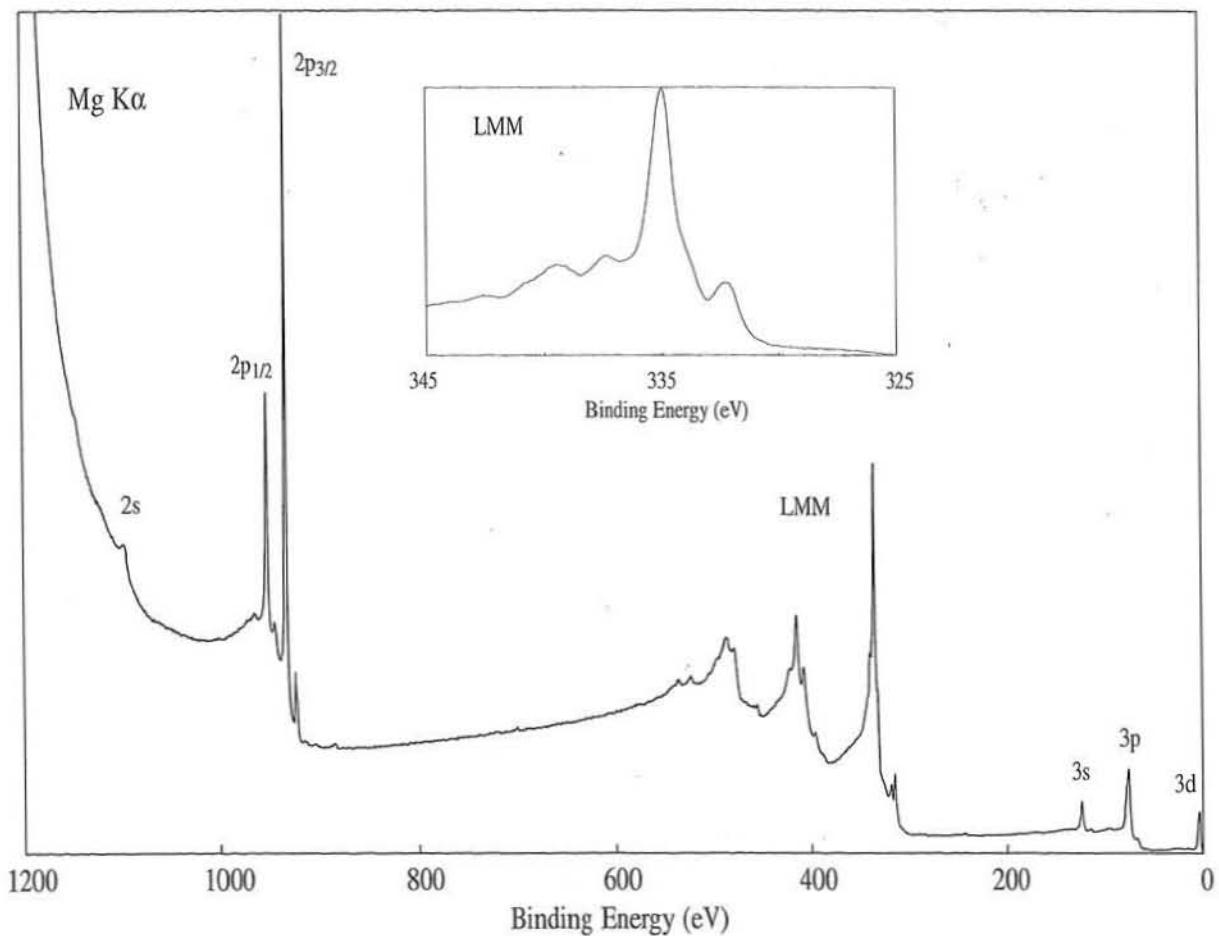
**Handbook of X-ray Photoelectron Spectroscopy**

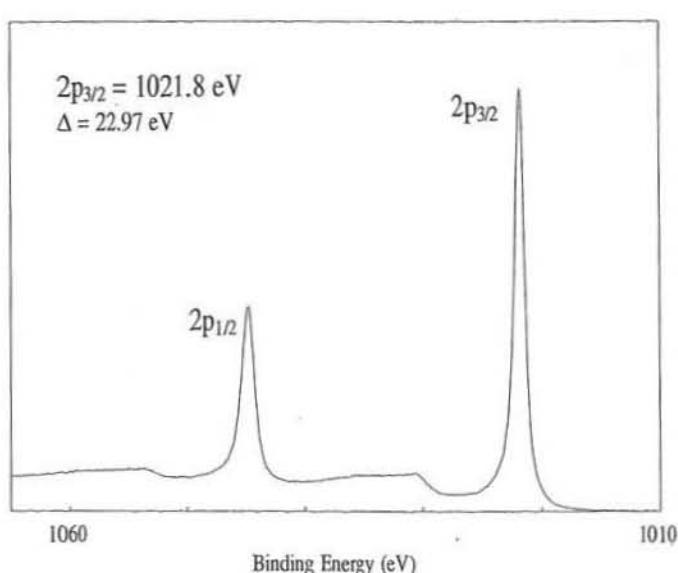
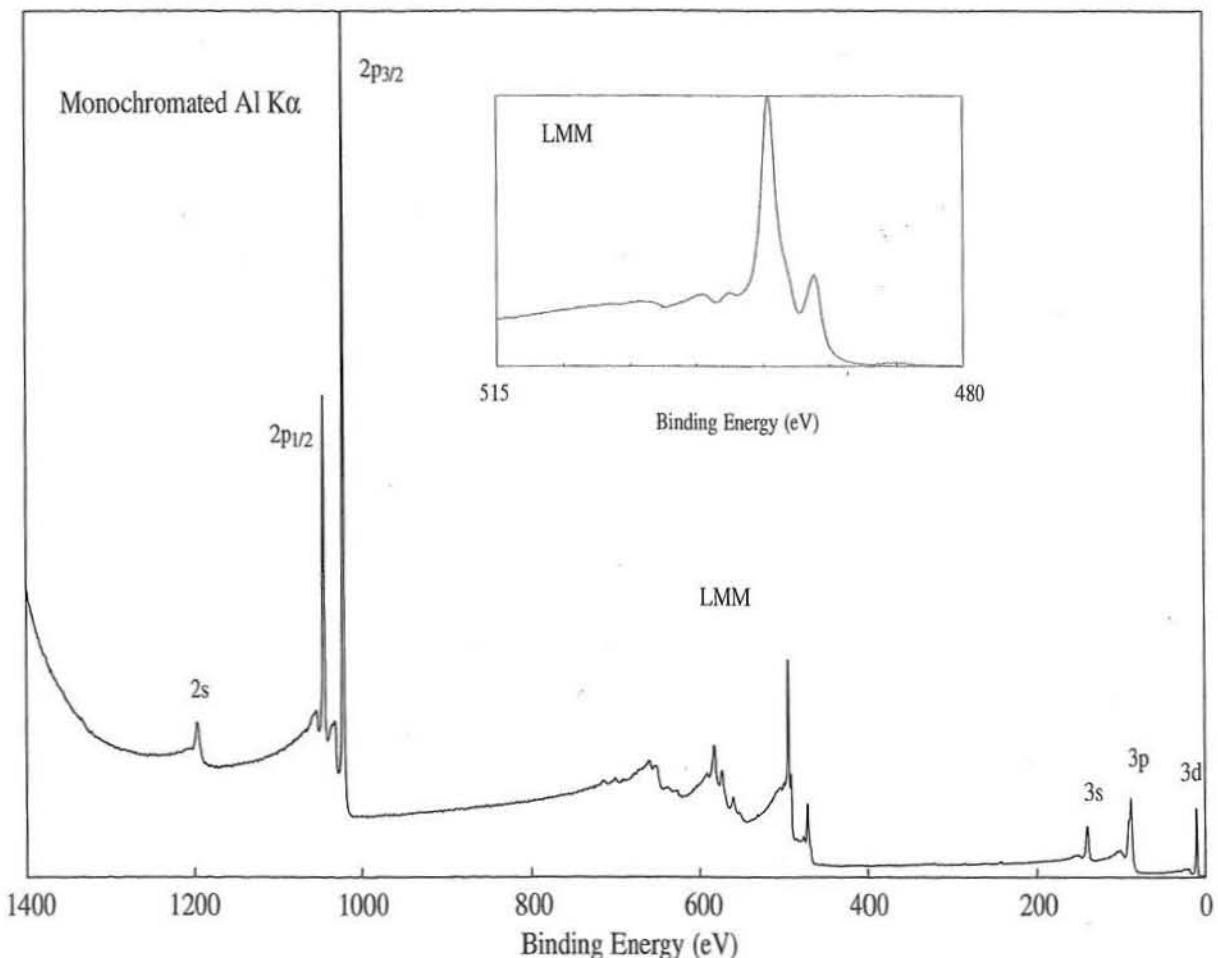


Line Positions (eV)					
<u>Photoelectron Lines</u>					
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>
1097	953	933	123	77	75
<u>Auger Lines</u>					
L <sub>3</sub> M <sub>23</sub> M <sub>23</sub>	L <sub>2</sub> M <sub>23</sub> M <sub>23</sub>	L <sub>3</sub> M <sub>23</sub> M <sub>45</sub> ( <sup>1</sup> P)			
719	712	648 (Al)			
486	479	415 (Mg)			
L <sub>3</sub> M <sub>23</sub> M <sub>45</sub> ( <sup>3</sup> P)	L <sub>2</sub> M <sub>23</sub> M <sub>45</sub> ( <sup>1</sup> P)	L <sub>3</sub> M <sub>45</sub> M <sub>45</sub>	L <sub>2</sub> M <sub>45</sub> M <sub>45</sub>		
640	628	568	548 (Al)		
407	395	335	315 (Mg)		

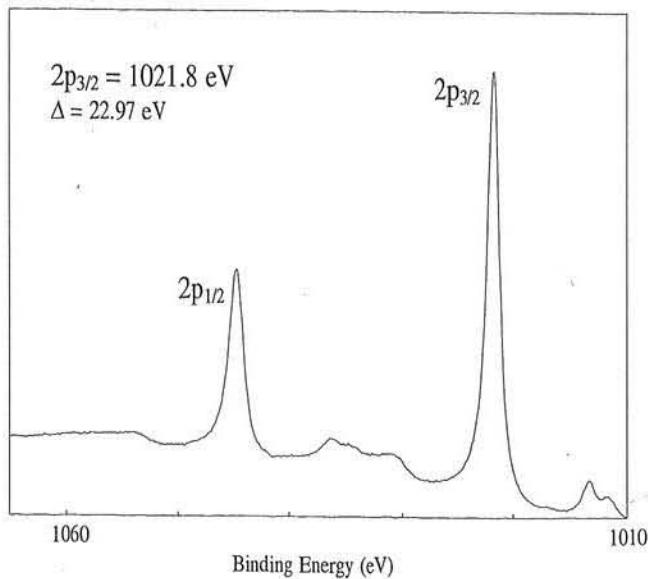
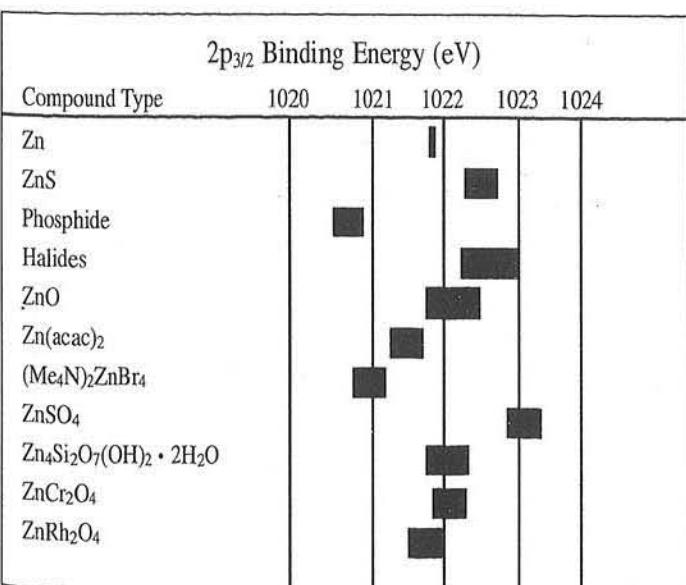
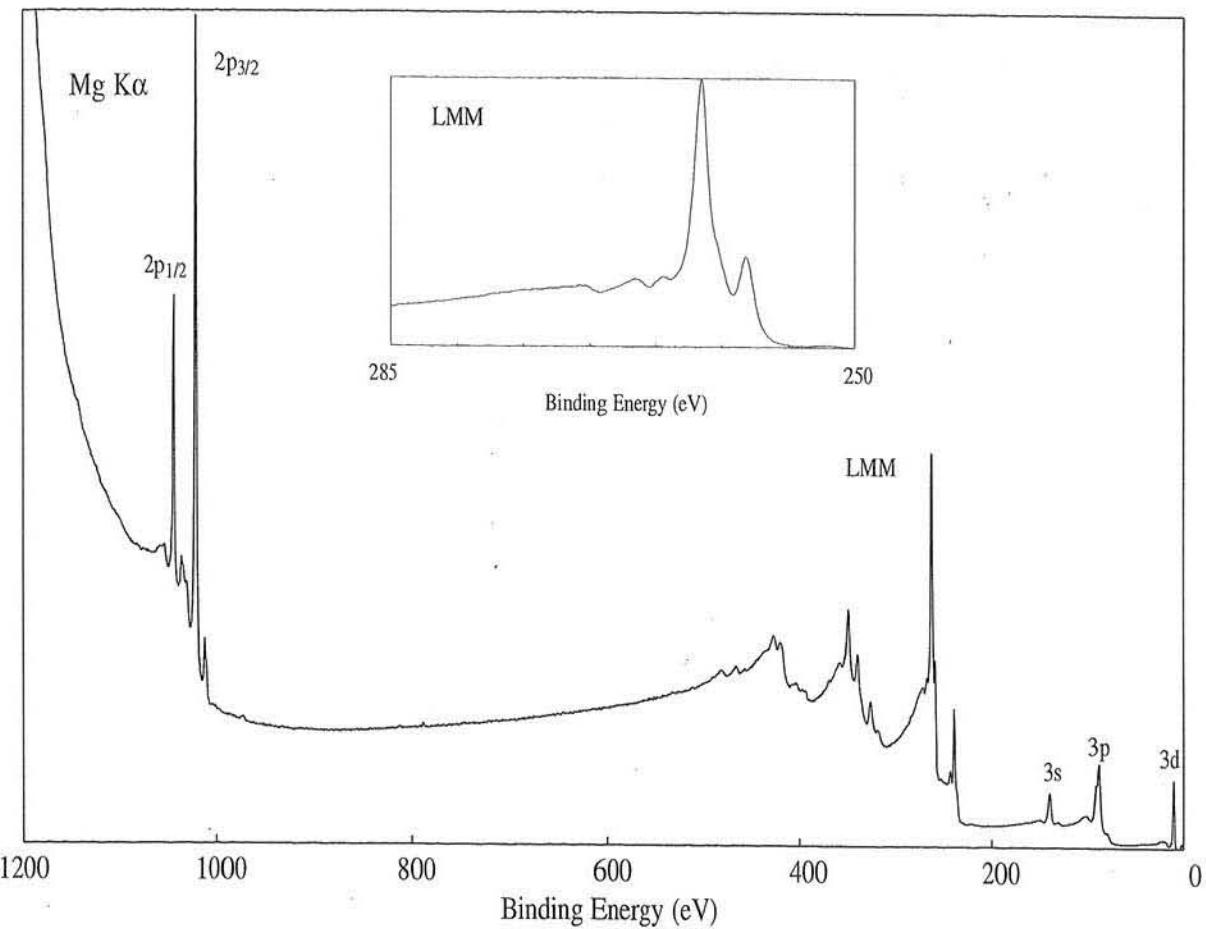


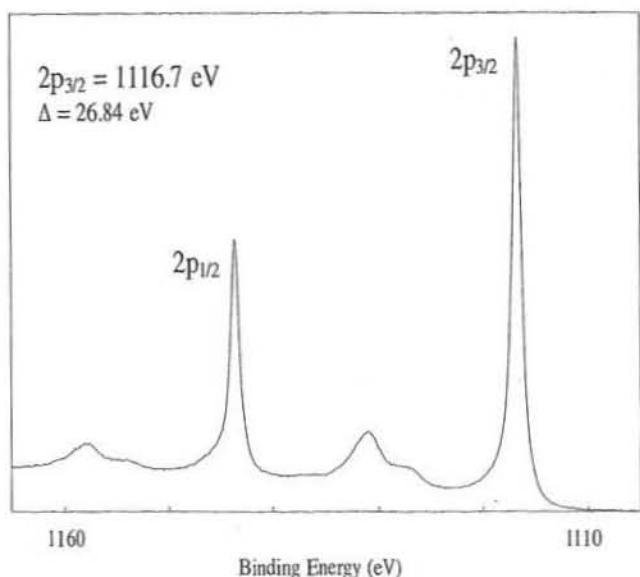
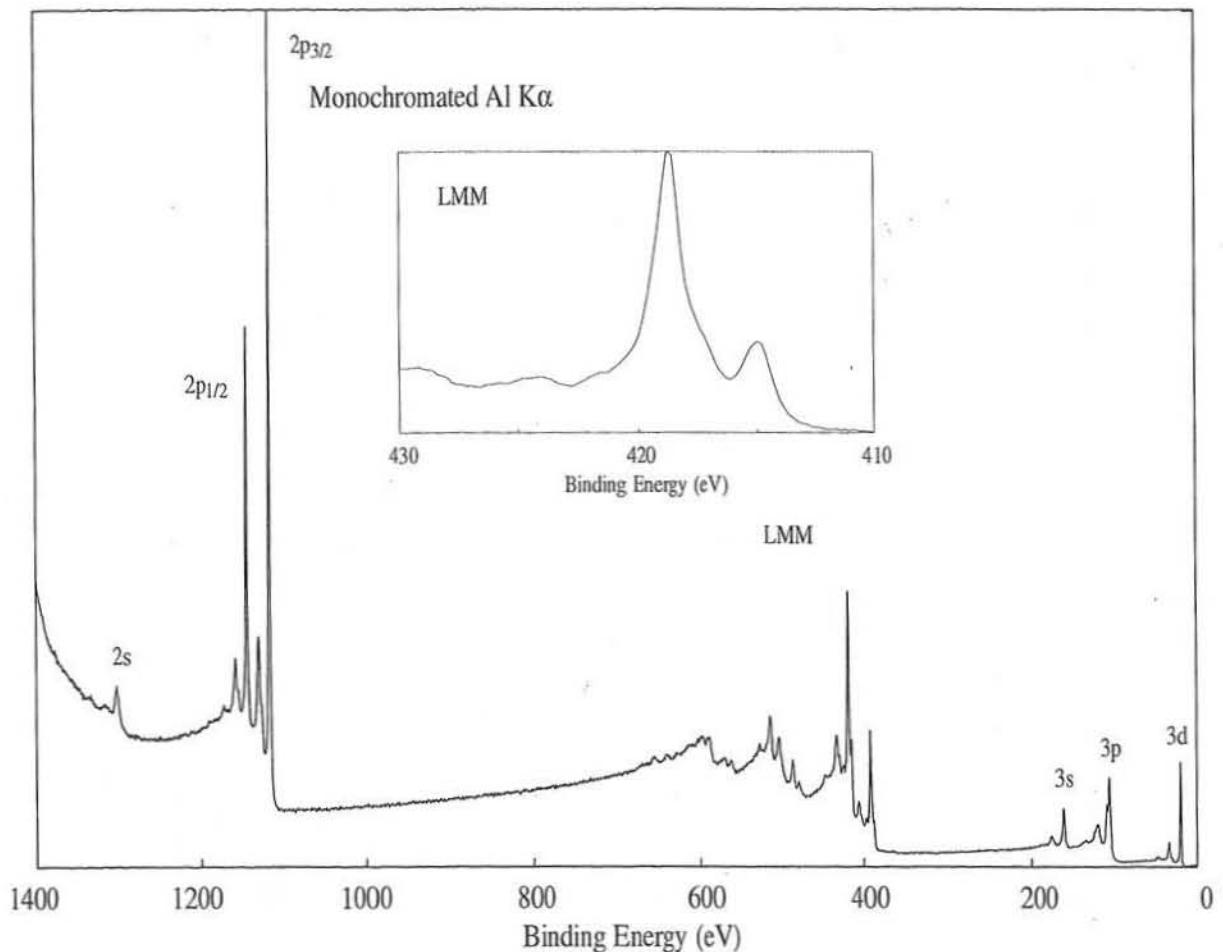
Perkin-Elmer Corporation  
Physical Electronics Division



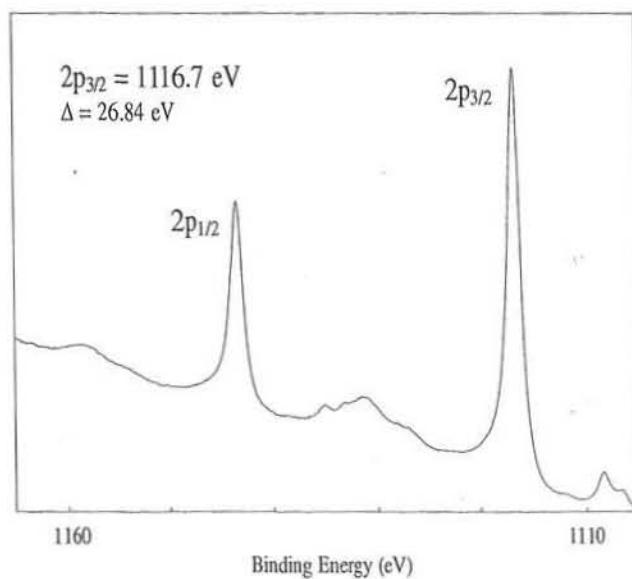
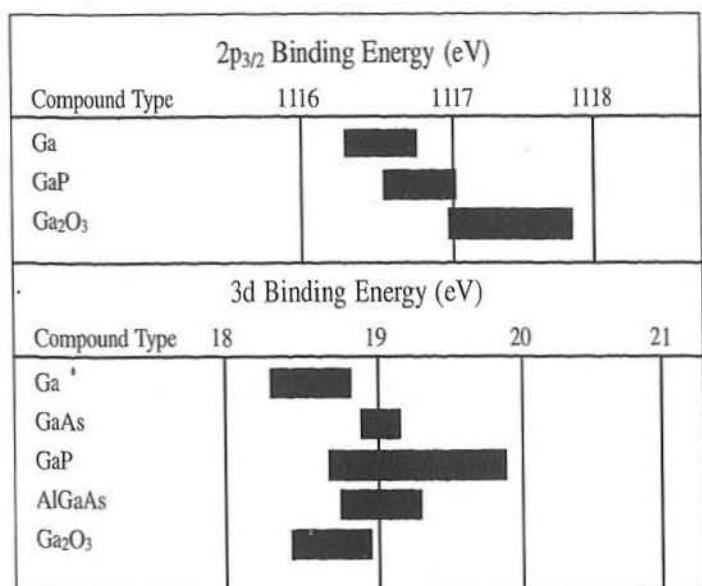
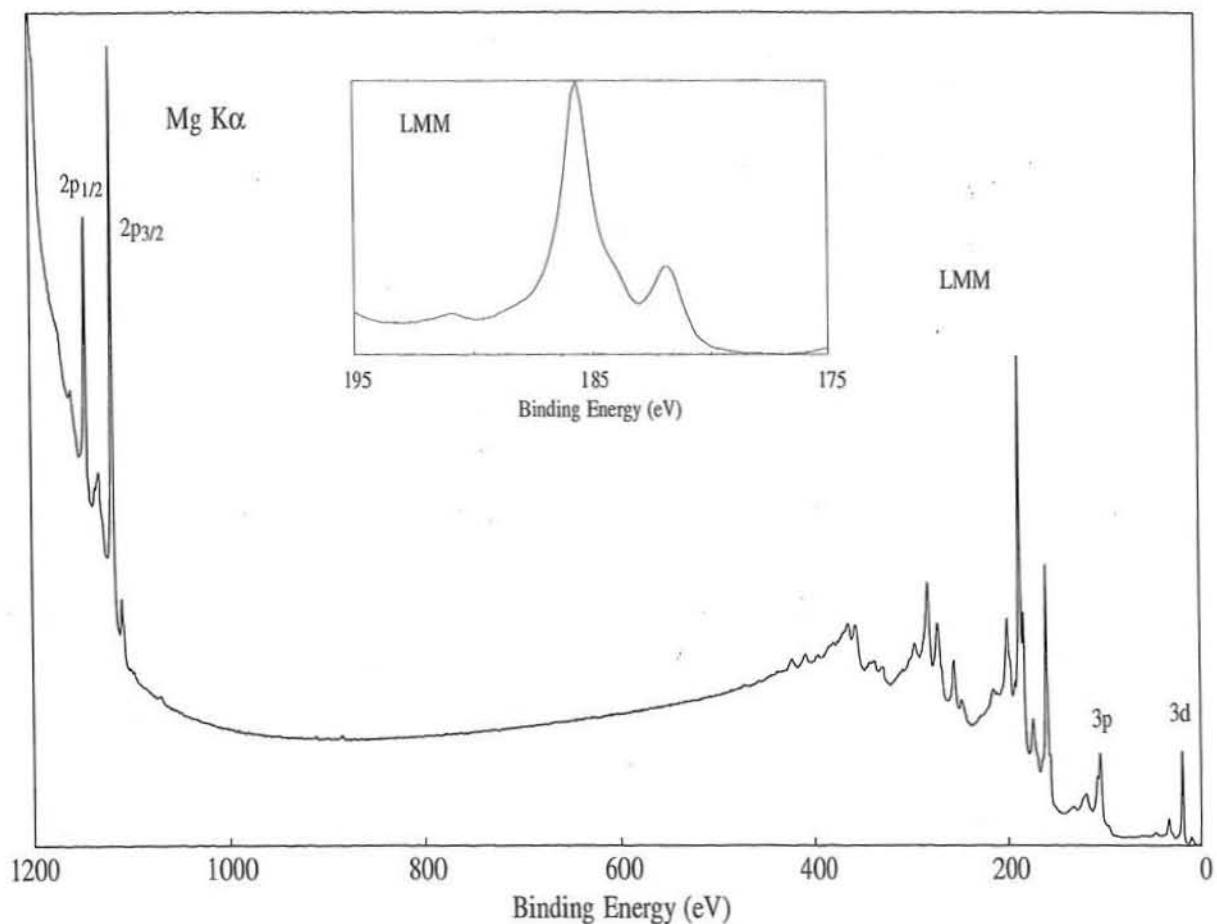


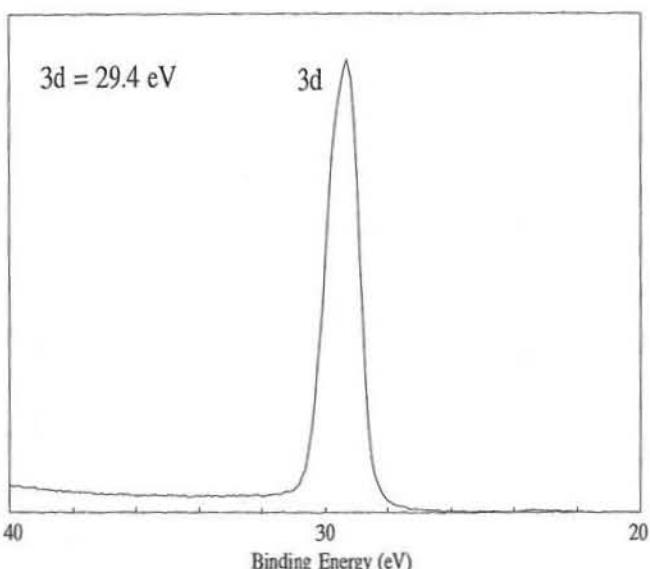
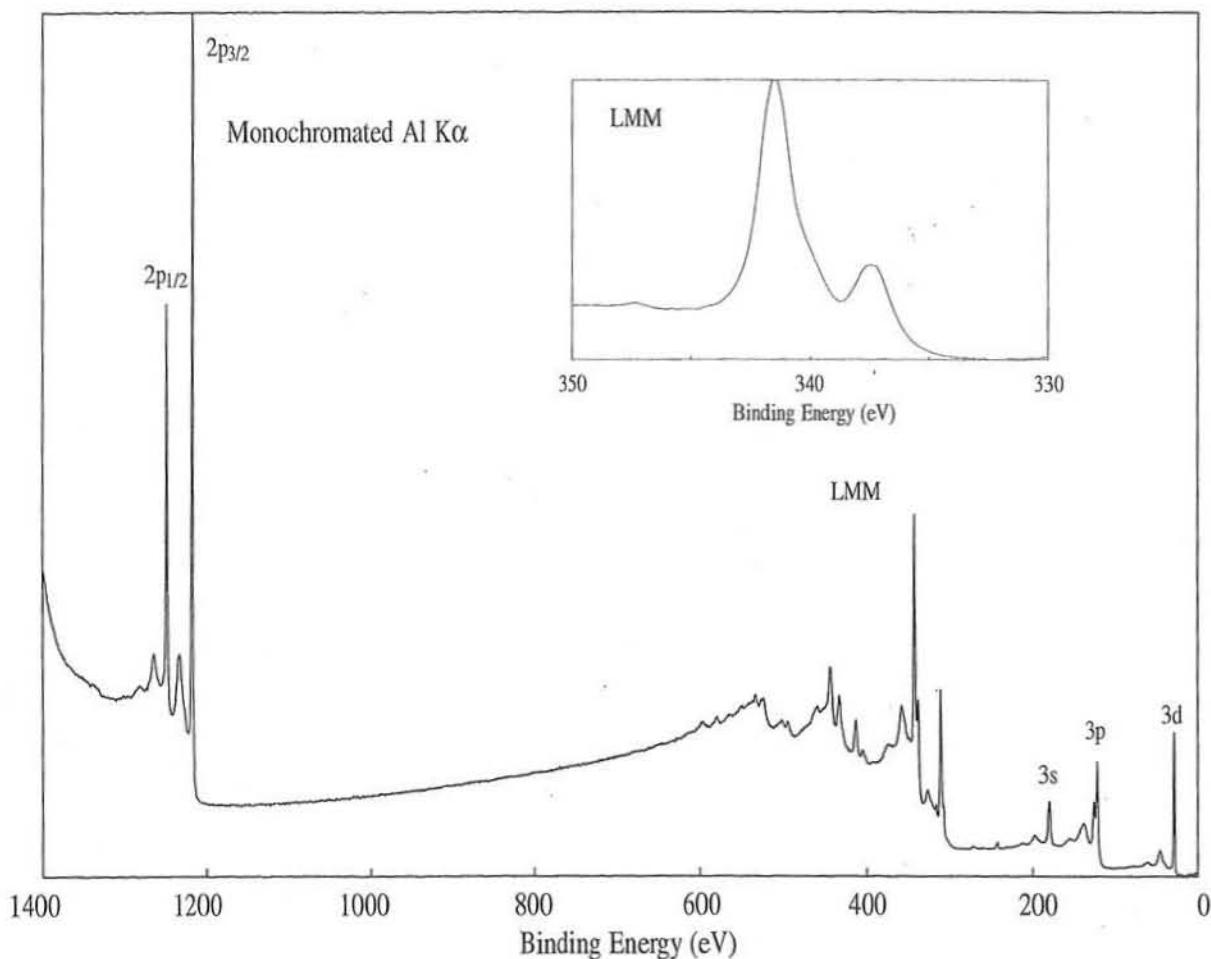
Line Positions (eV)						
Photoelectron Lines						
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d
1195	1045	1022	140	91	89	10
Auger Lines						
$L_3M_{23}M_{23}$	$L_2M_{23}M_{23}$	$L_3M_{23}M_{45}$	$L_3M_{23}M_{45}$	$L_2M_{23}M_{45}$	$L_3M_{45}M_{45}$	$L_2M_{45}M_{45}$
660	652	582	$(Al)$	427	419	349
						$(Mg)$
$L_3M_{23}M_{45}$	$L_2M_{23}M_{45}$	$L_3M_{45}M_{45}$	$L_2M_{45}M_{45}$	$(^3P)$	$(^1P)$	$(Al)$
573	559	495	472			
340	326	262	239			$(Mg)$



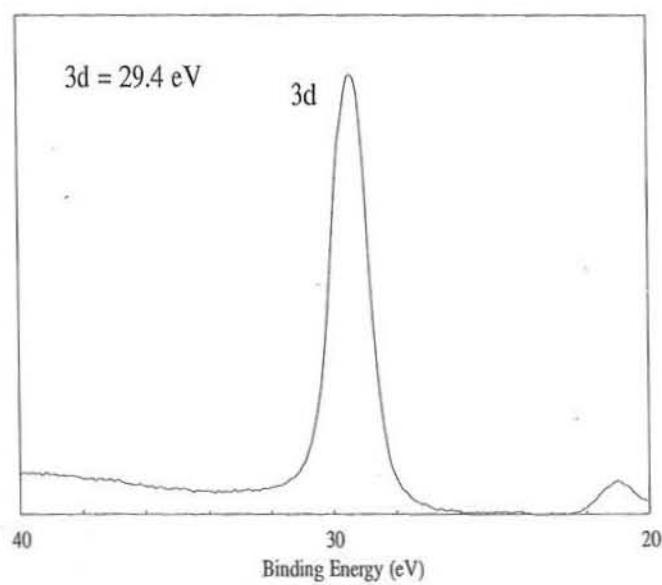
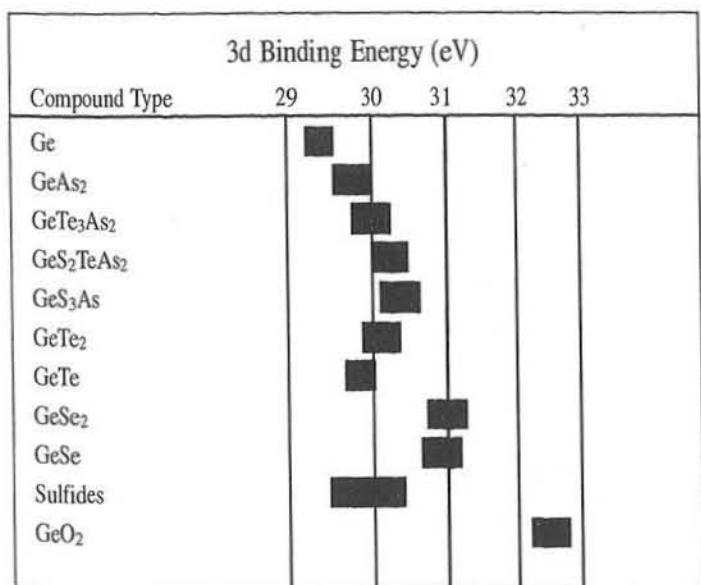
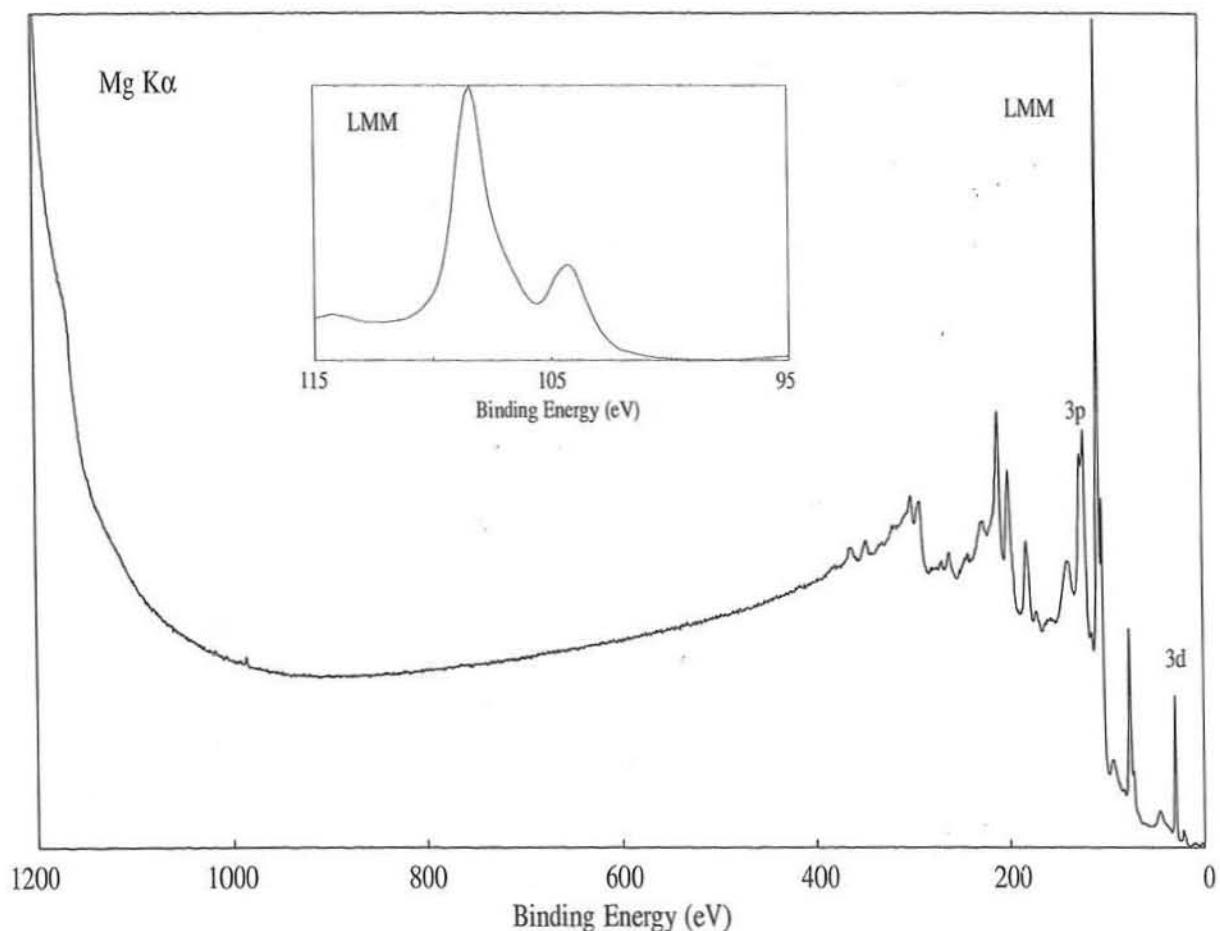


Line Positions (eV)						
Photoelectron Lines						
2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d
1301	1144	1117	160	107	104	19
Auger Lines						
$L_3M_{23}M_{23}$	$L_2M_{23}M_{23}$	$L_3M_{23}M_{45}$	$L_3M_{23}M_{45}$	$L_2M_{23}M_{45}$	$L_3M_{45}M_{45}$	$L_2M_{45}M_{45}$
597	589	514	(Al)	364	356	281
504	487	419		271	254	186
			(Mg)			159
			(Al)			



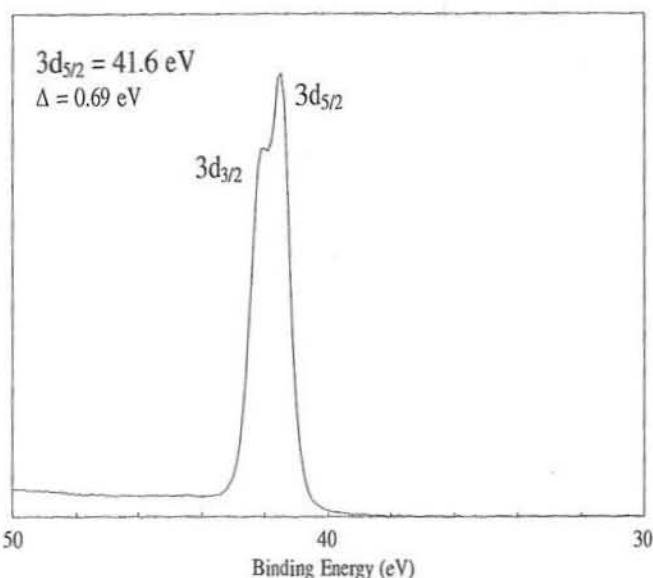
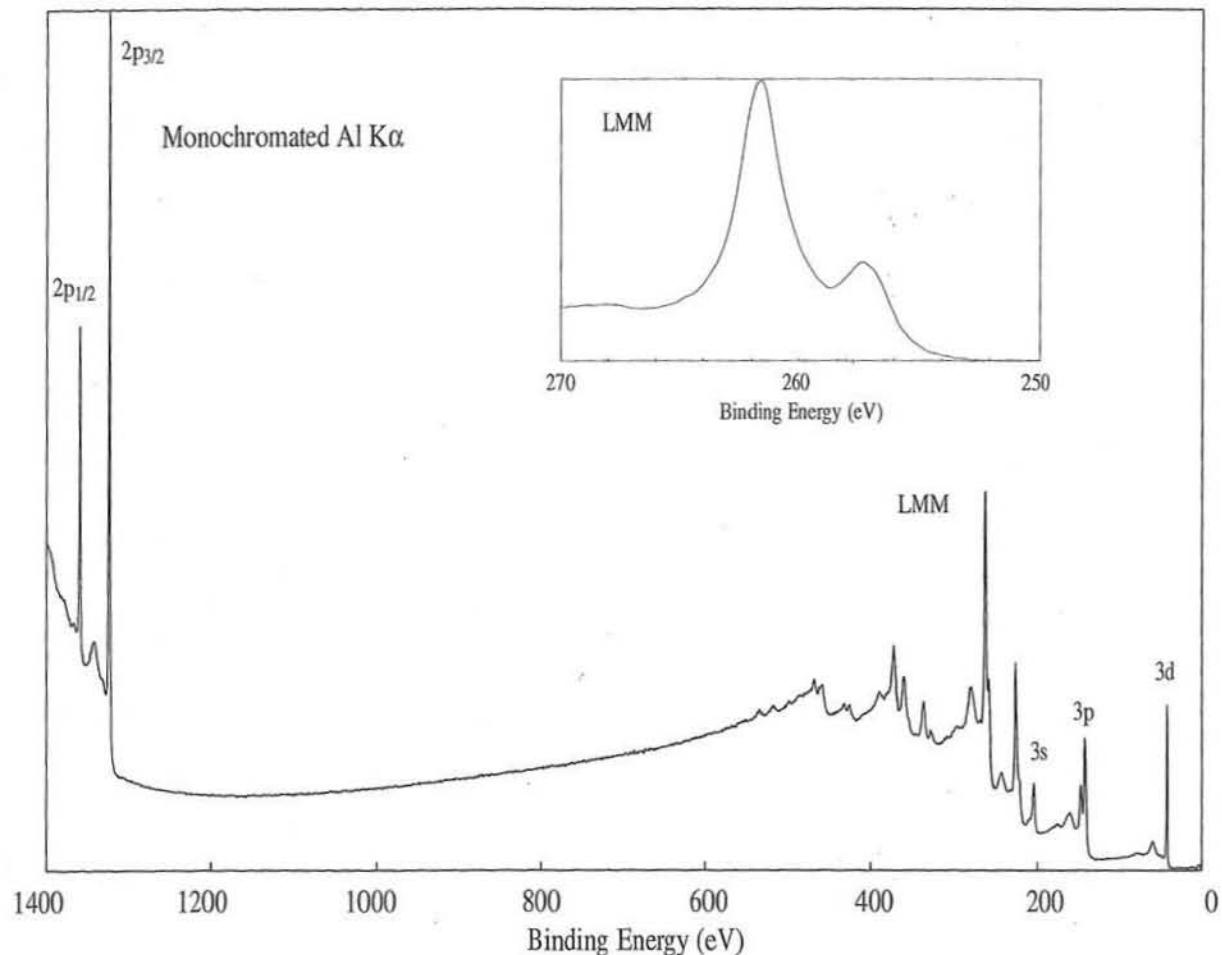


Line Positions (eV)					
<u>Photoelectron Lines</u>					
$2p_{1/2}$	$2p_{3/2}$	$3s$	$3p_{1/2}$	$3p_{3/2}$	$3d$
1248	1217	181	126	122	29
<u>Auger Lines</u>					
$L_3M_{23}M_{23}$	$L_2M_{23}M_{23}$	$L_3M_{23}M_{45}$ ( $^1P$ )			
534	525	444	(Al)		
301	292	211	(Mg)		
$L_3M_{23}M_{45}$ ( $^3P$ )	$L_2M_{23}M_{45}$ ( $^1P$ )	$L_3M_{45}M_{45}$	$L_2M_{45}M_{45}$		
433	412	342	310		
200	179	109	77		
				(Al)	(Mg)



**Arsenic      As**  
**Atomic Number 33**

**Handbook of X-ray Photoelectron Spectroscopy**



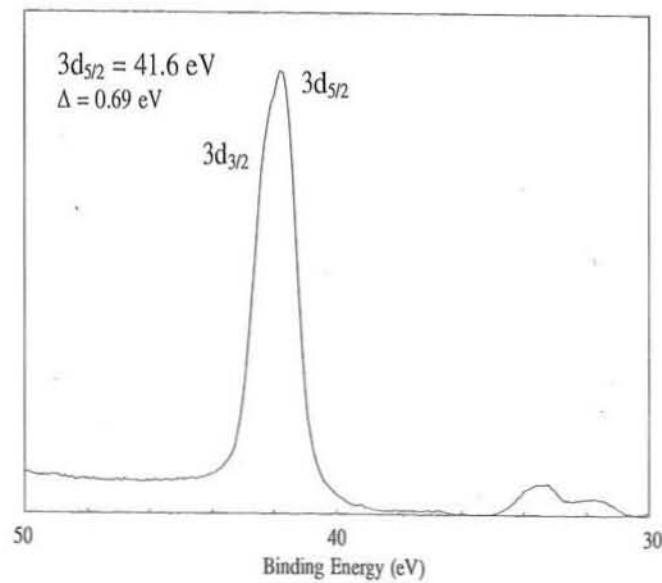
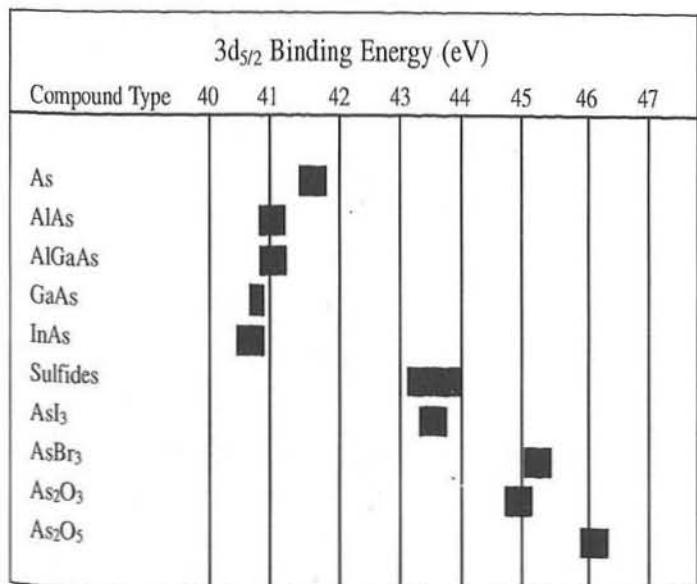
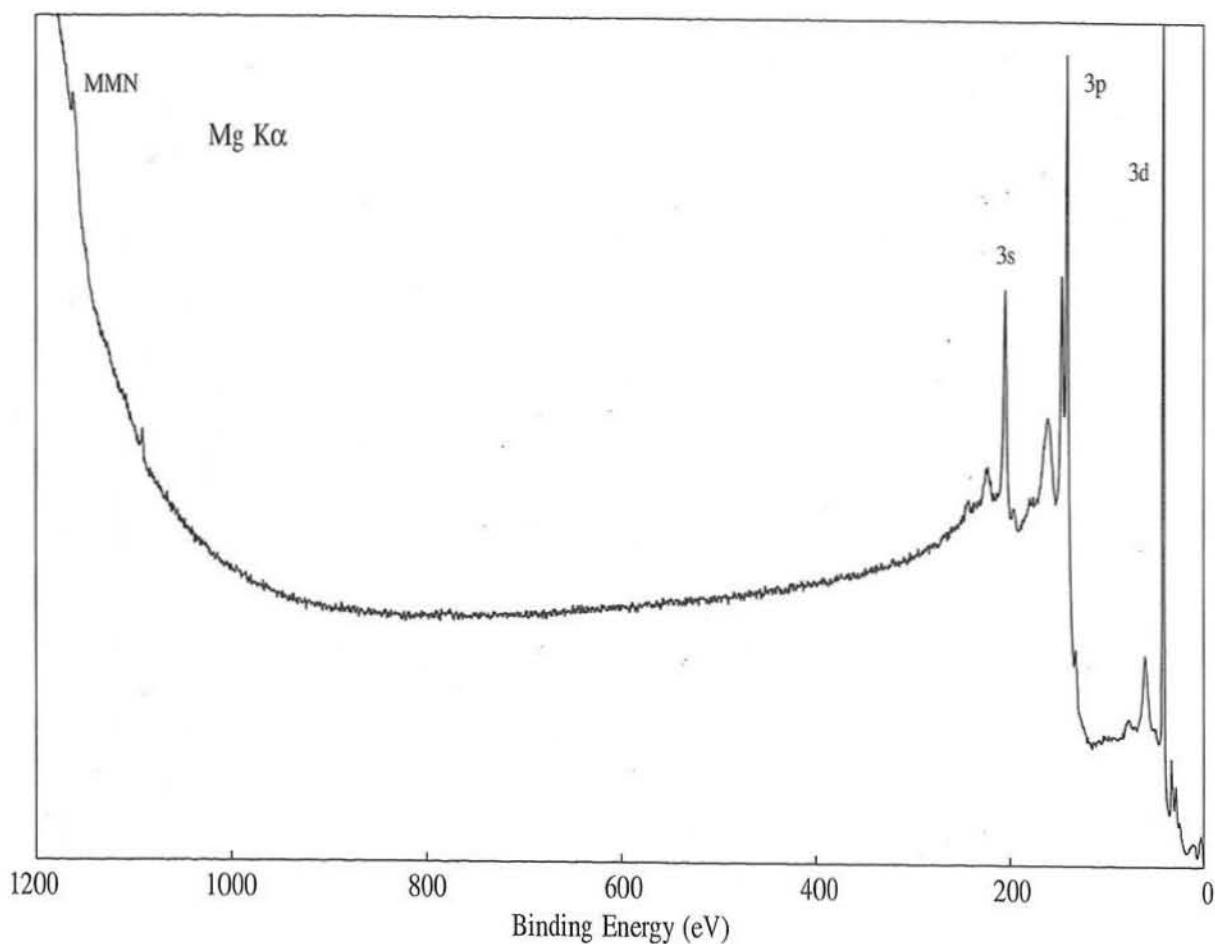
Line Positions (eV)						
Photoelectron Lines						
$2p_{1/2}$	$2p_{3/2}$	$3s$	$3p_{1/2}$	$3p_{3/2}$	$3d_{3/2}$	$3d_{5/2}$
1359	1324	205	146	141	43	42

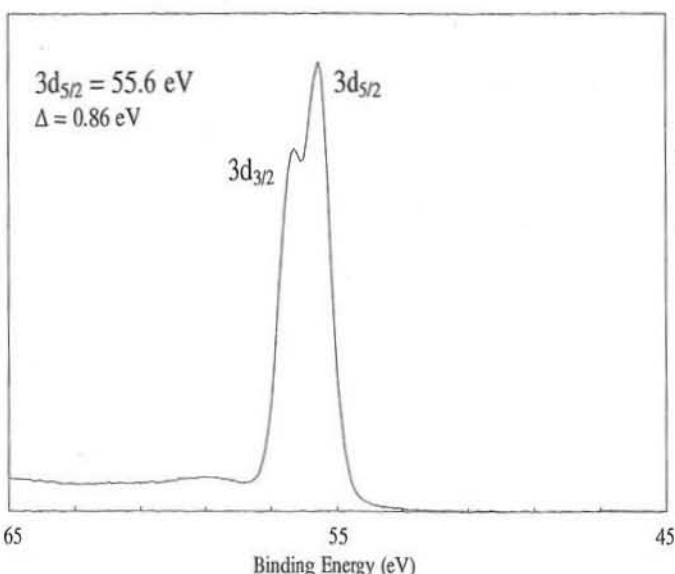
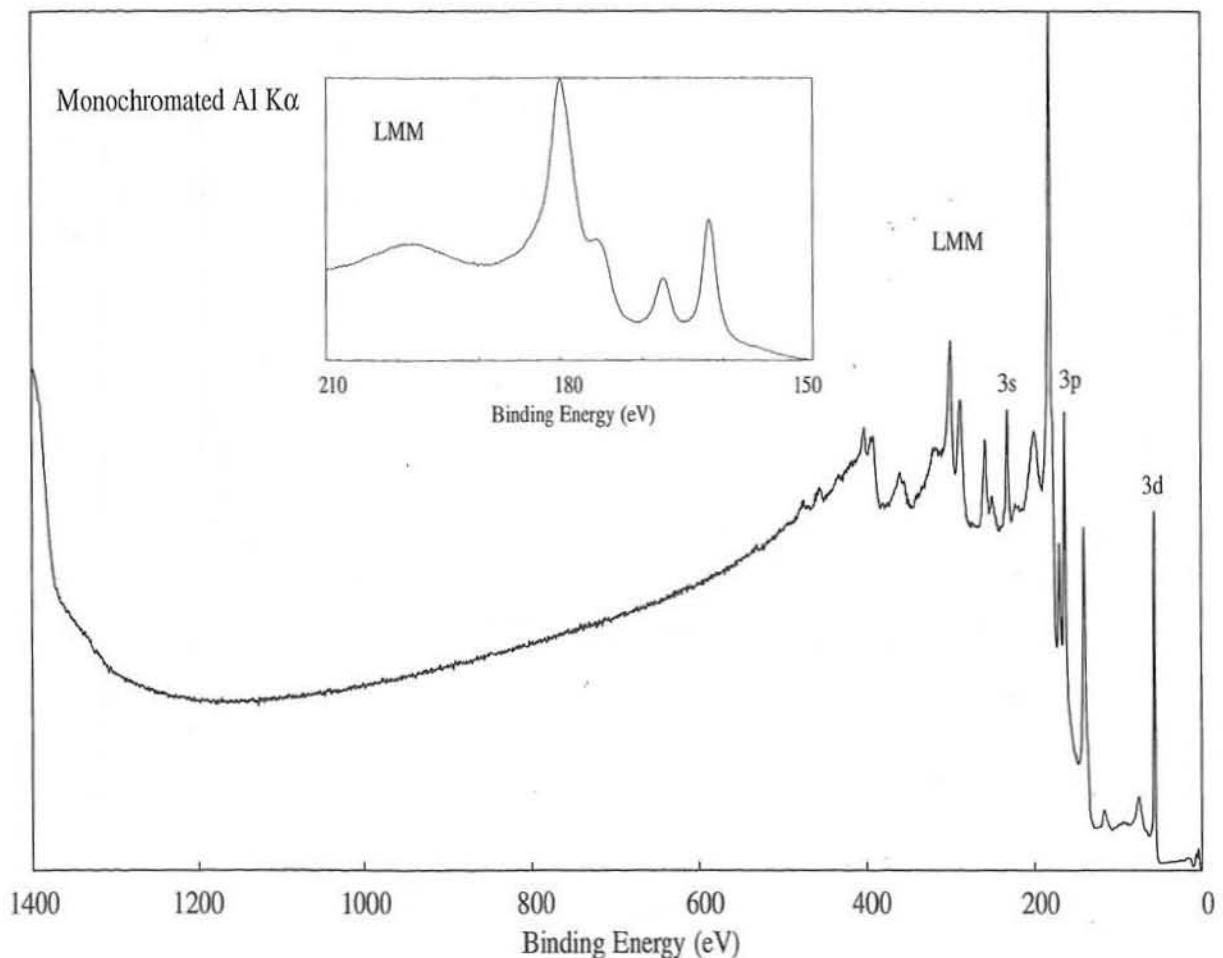
  

Auger Lines		
$L_3M_{23}M_{45}$ ( $^1P$ )	$L_3M_{23}M_{45}$ ( $^3P$ )	
371	360	(Al)
$L_2M_{23}M_{45}$ ( $^1P$ )	$L_3M_{45}M_{45}$	$L_2M_{45}M_{45}$
336	262	226
		(Al)

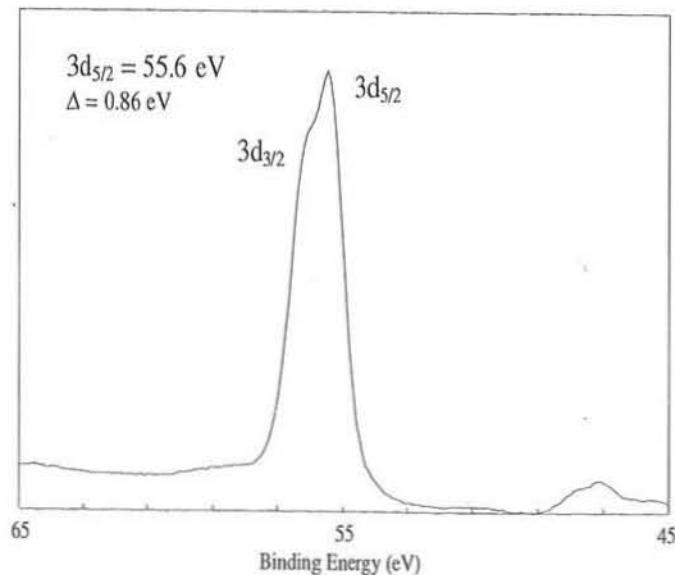
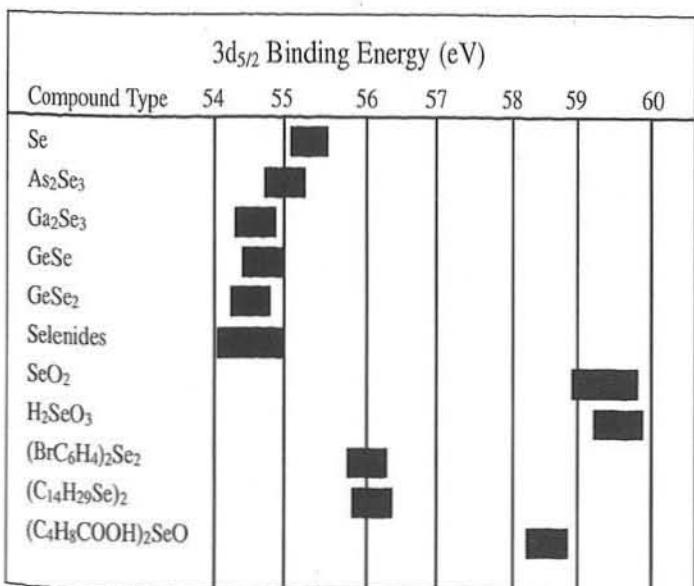
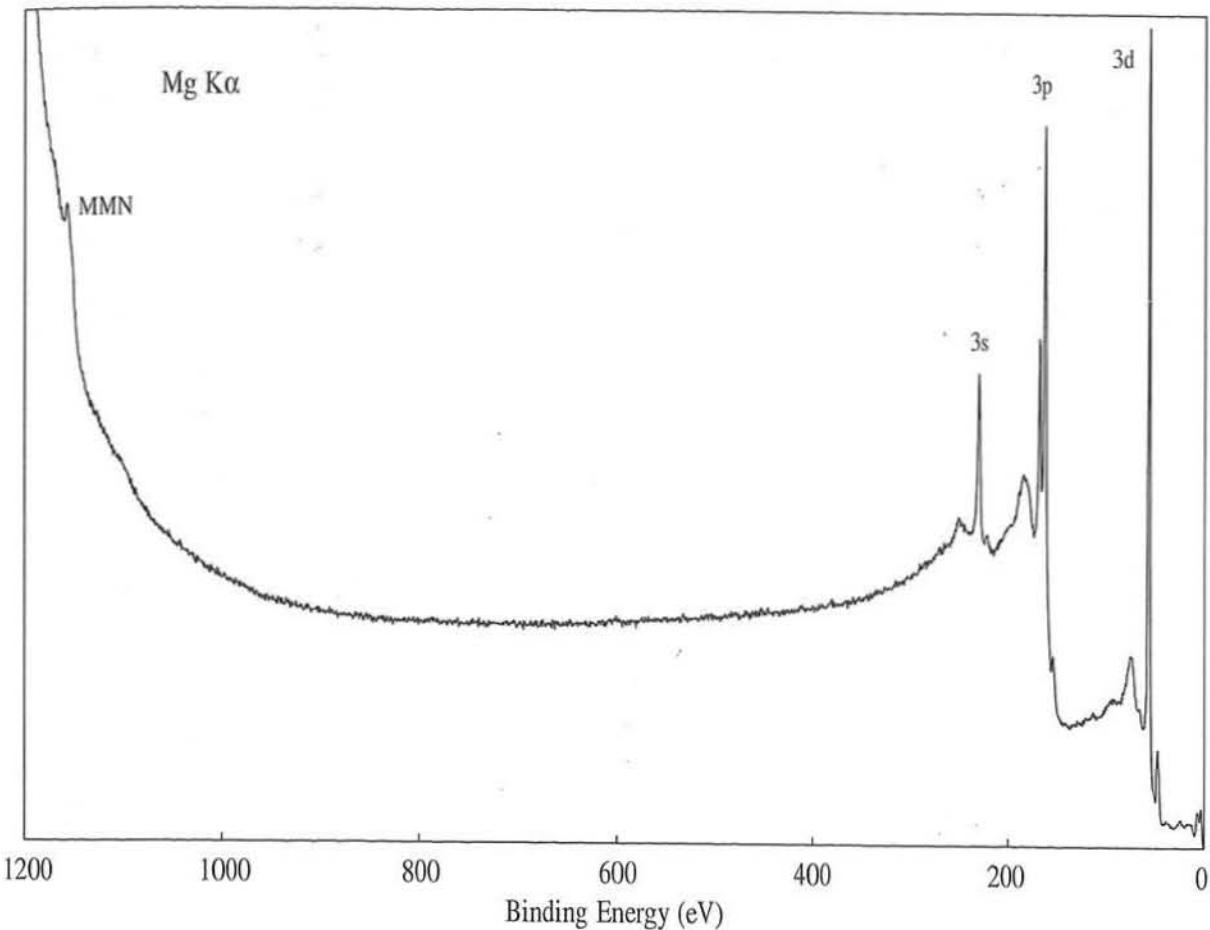


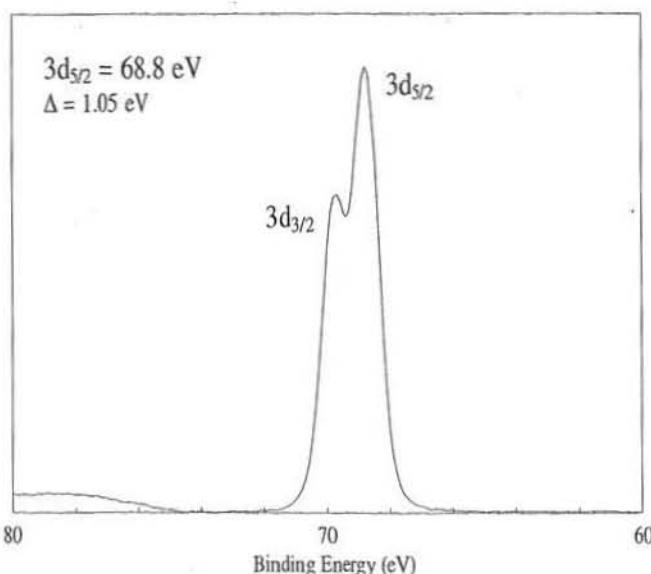
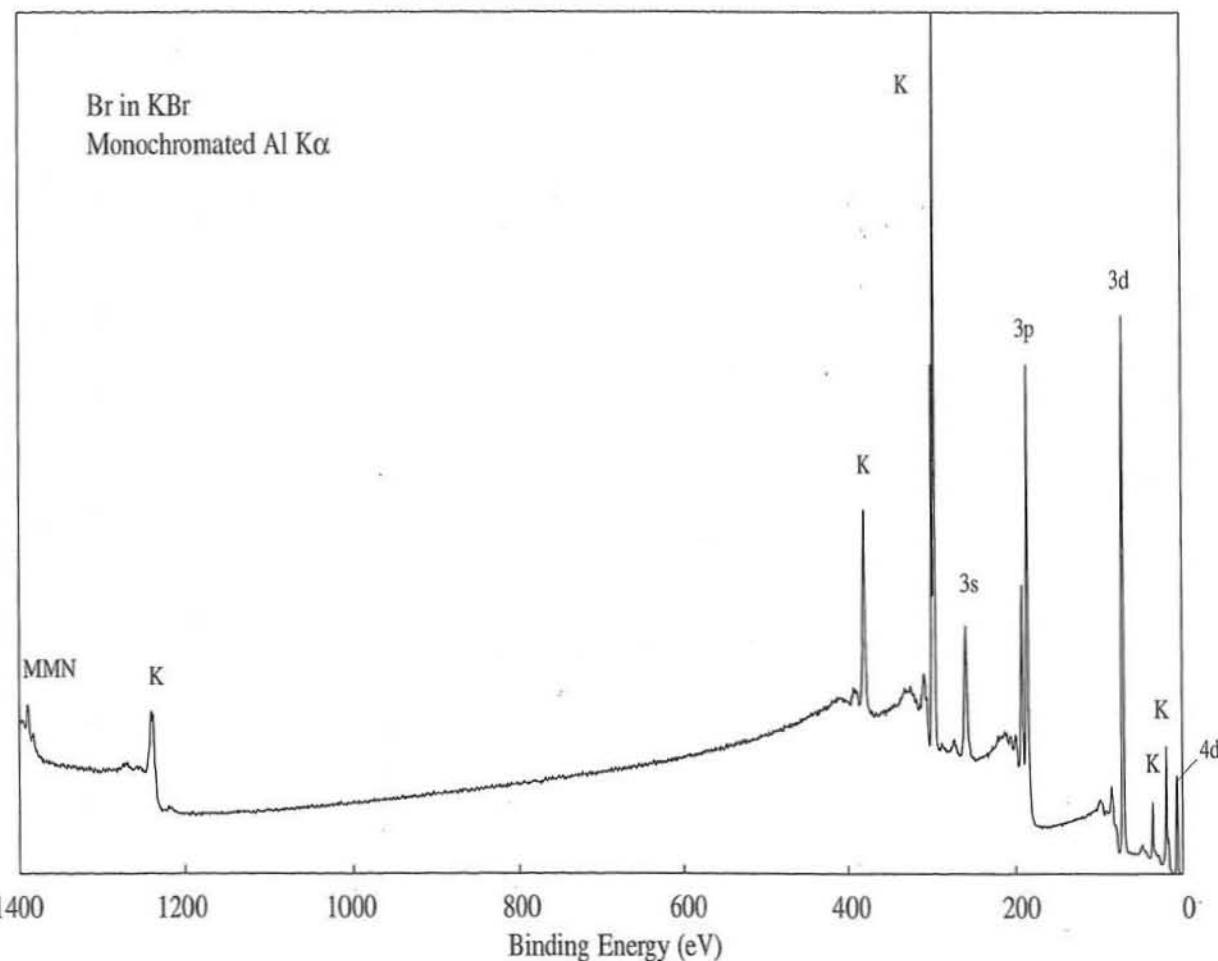
**Perkin-Elmer Corporation**  
**Physical Electronics Division**





Line Positions (eV)				
<u>Photoelectron Lines</u>				
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>
232	169	163	57	56
<u>Auger Lines</u>				
$L_3M_{23}M_{45}$ ( <sup>1</sup> P) 299	$L_3M_{23}M_{45}$ ( <sup>3</sup> P) 287 (Al)			
$L_2M_{23}M_{45}$ ( <sup>1</sup> P) 257	$L_3M_{45}M_{45}$ 181	$L_2M_{45}M_{45}$ 140 (Al)		





Line Positions (eV)

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Photoelectron Lines

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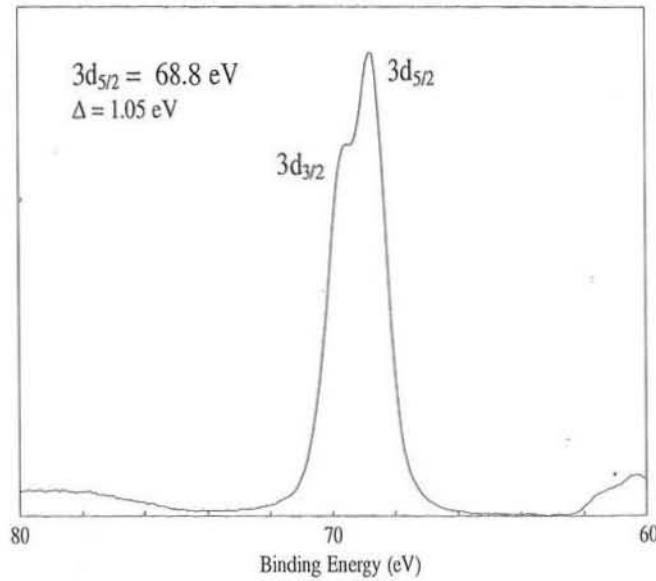
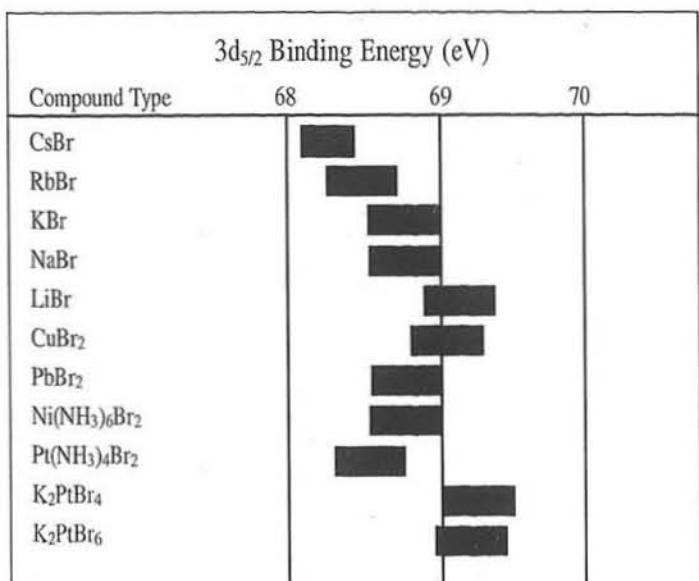
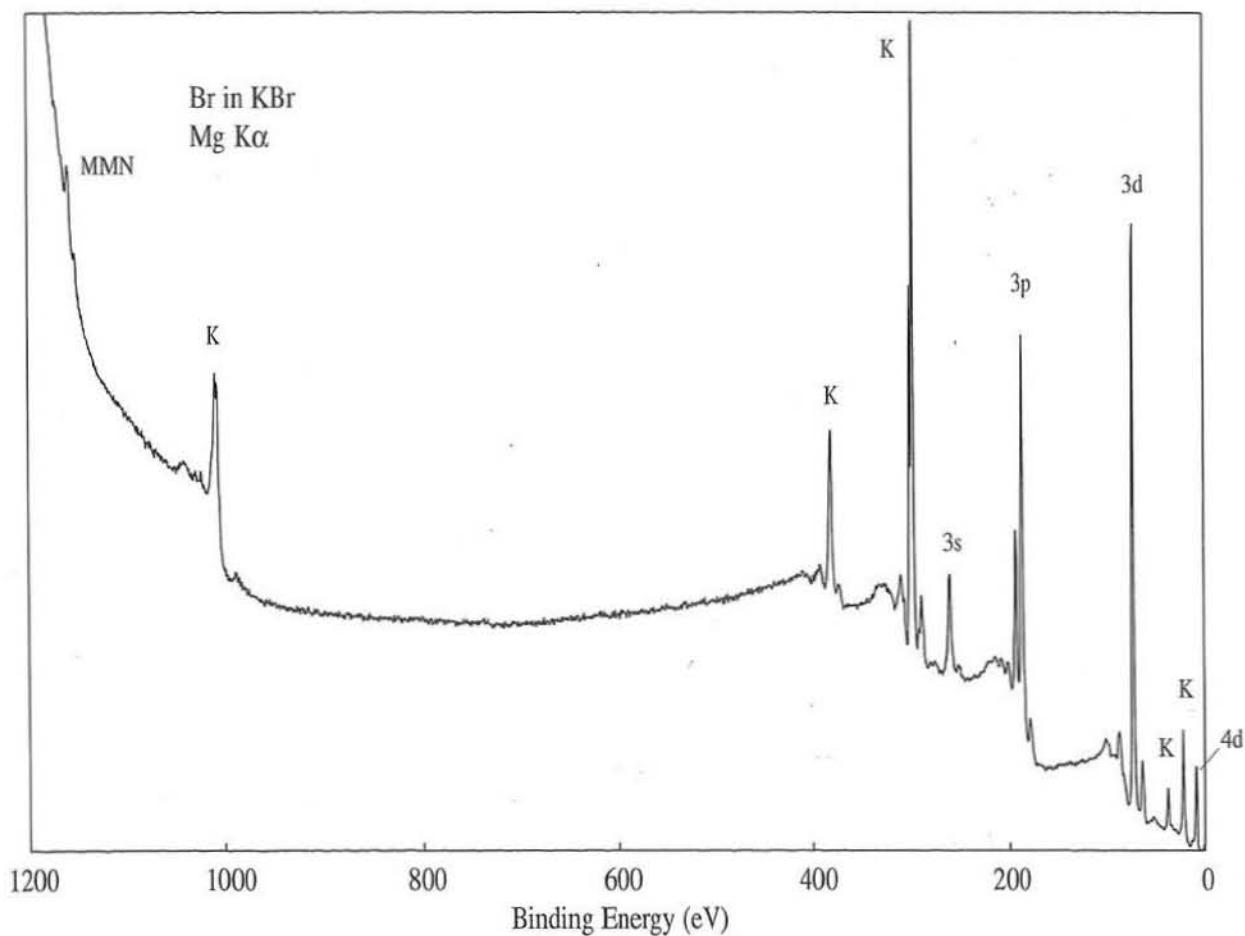
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4d
256	189	182	70	69	15	5

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Auger Lines

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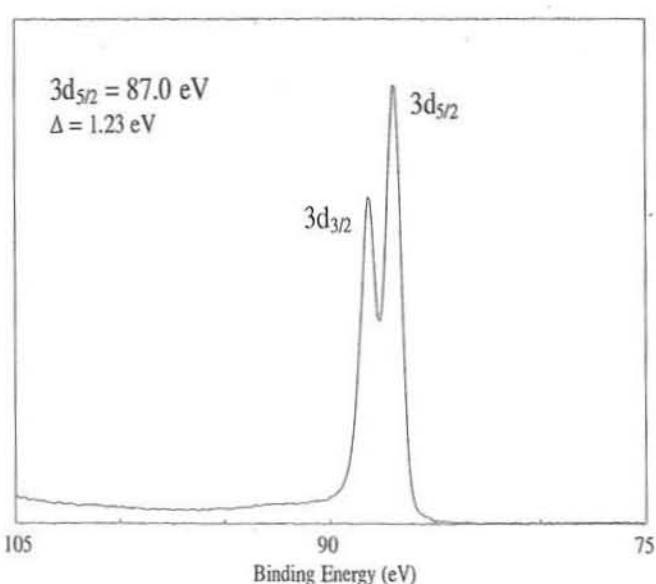
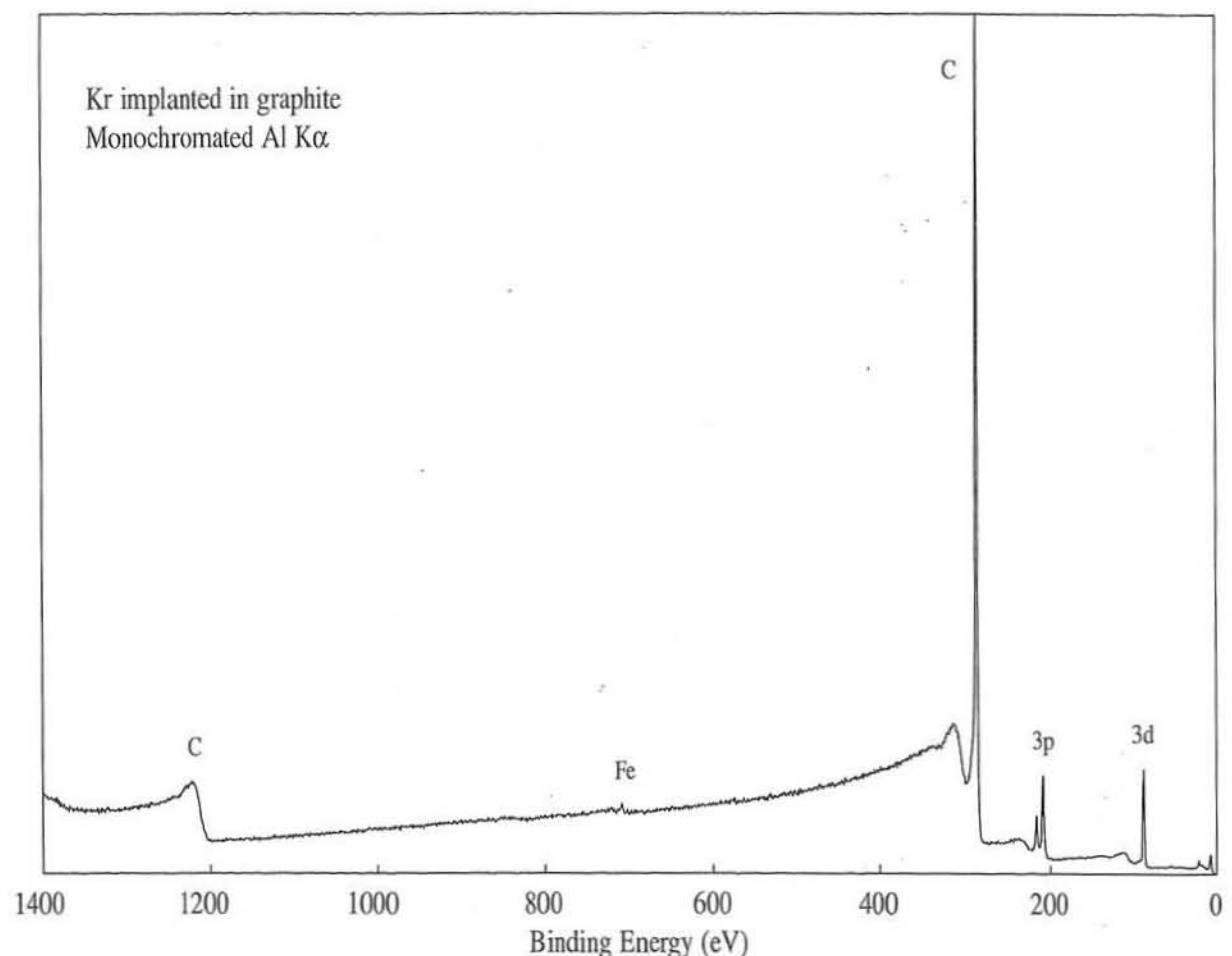
$M_{23}M_{45}N_{23}$	
1390	(Al)
1157	(Mg)



# Krypton Kr

Atomic Number 36

## Handbook of X-ray Photoelectron Spectroscopy

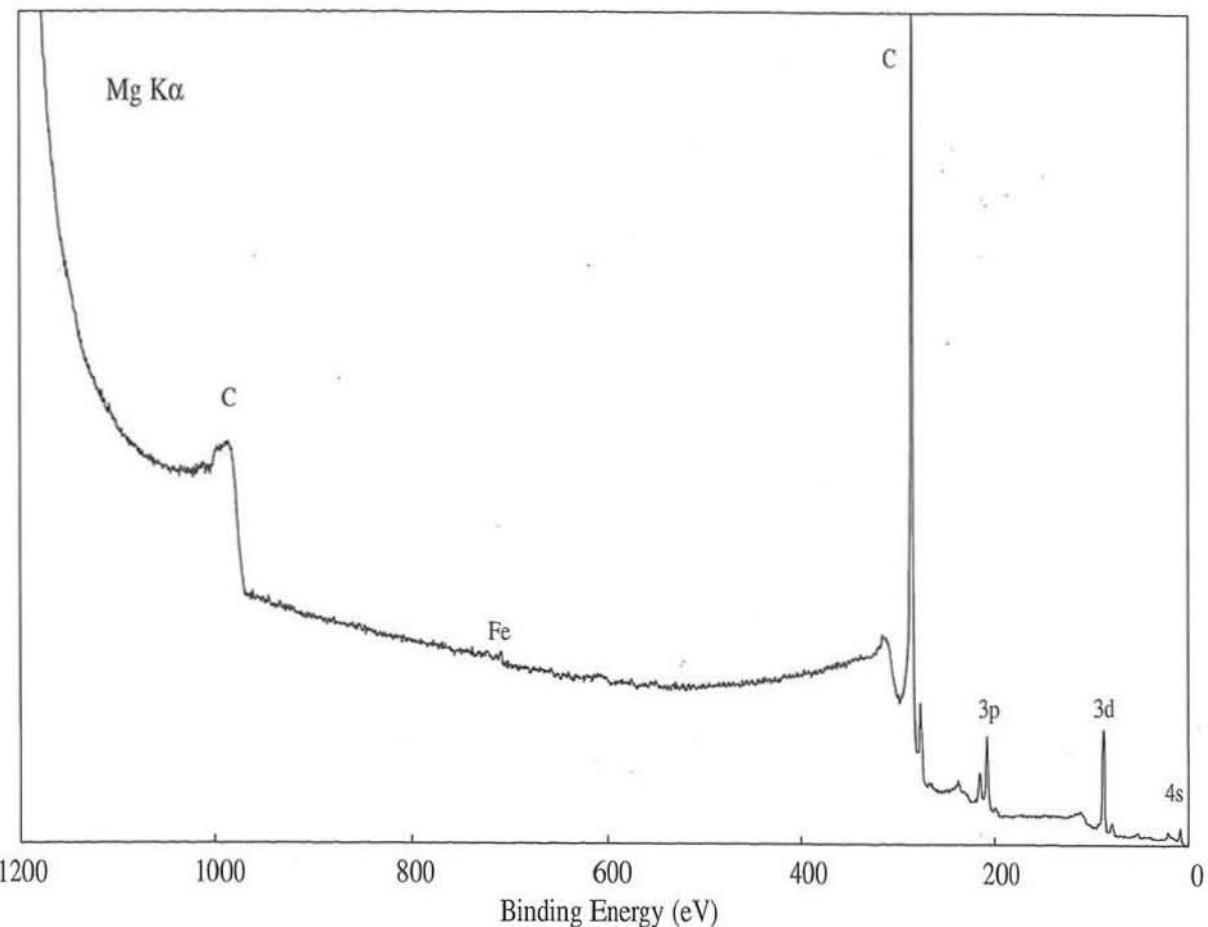


Line Positions (eV)

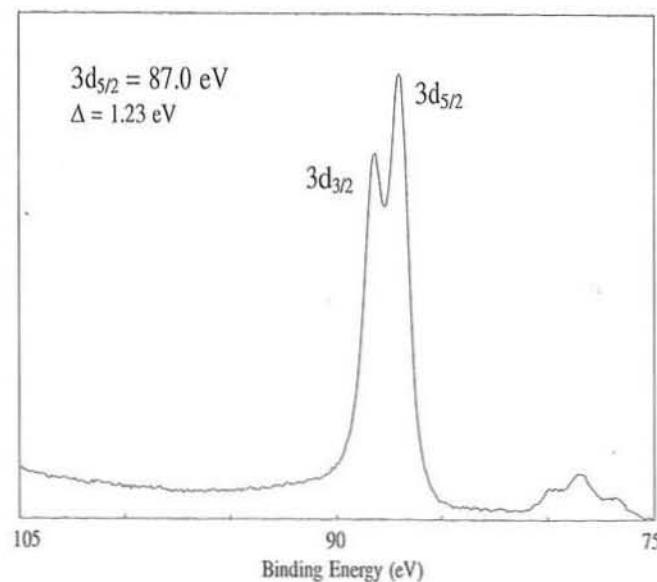
Photoelectron Lines

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	3s*	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p
Estimate	287	216	208	88	87	21	8



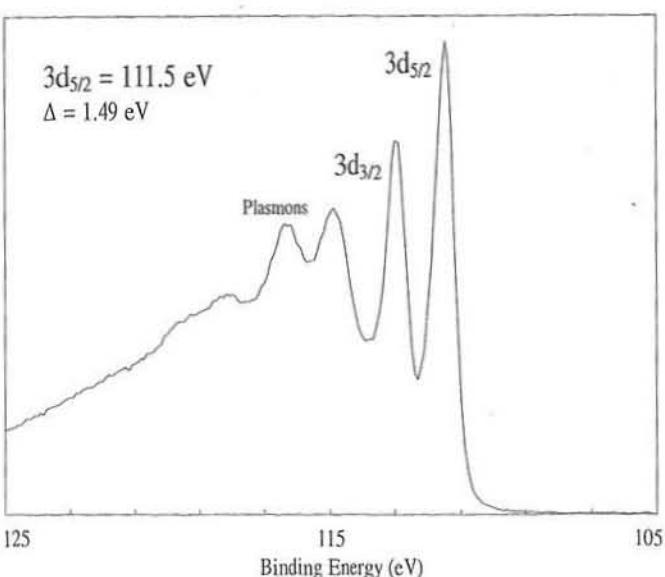
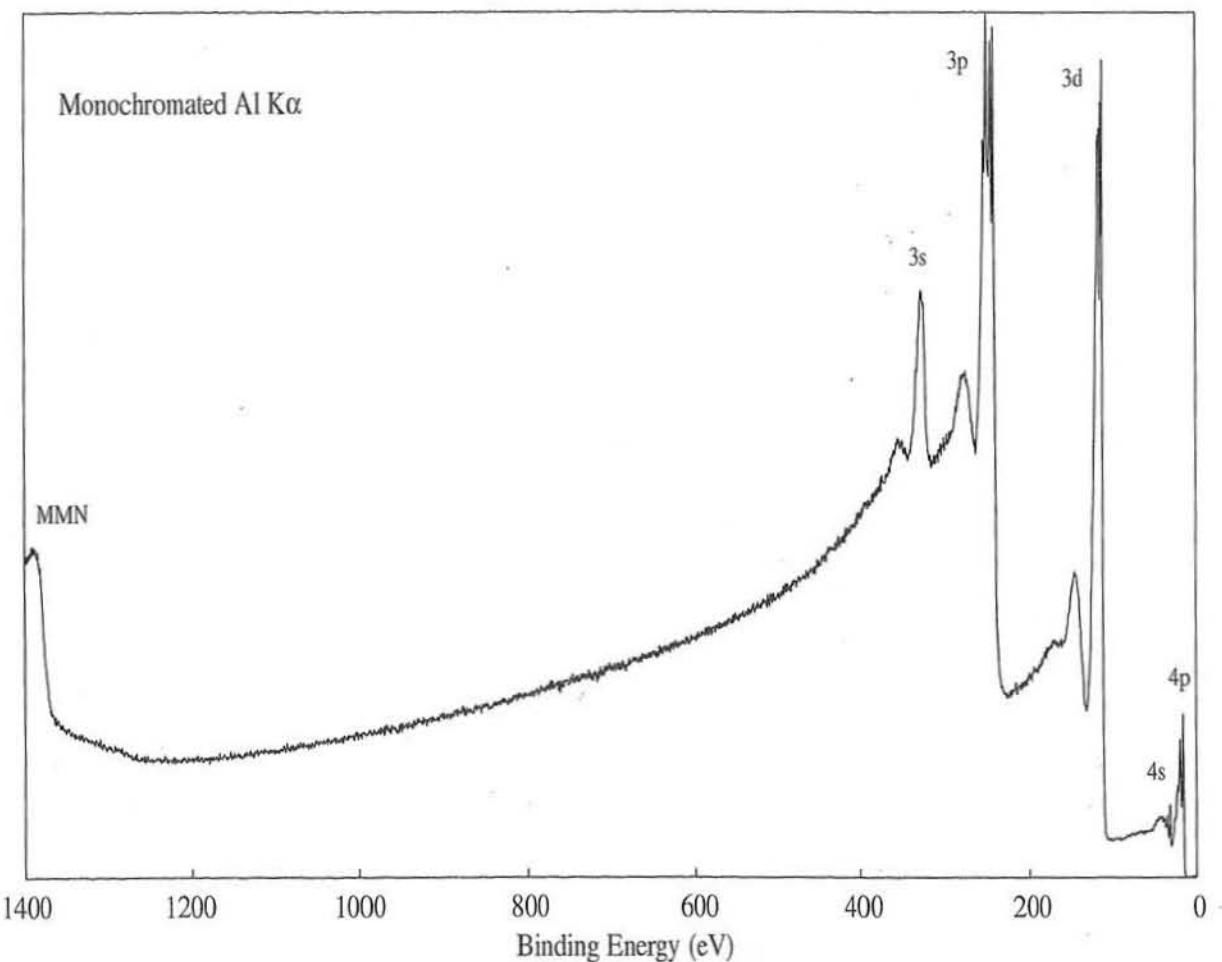
3d <sub>5/2</sub> Binding Energy (eV)				
Compound Type	84	86	88	
Kr in graphite		■		



# Rubidium Rb

Atomic Number 37

## Handbook of X-ray Photoelectron Spectroscopy



Line Positions (eV)

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Photoelectron Lines

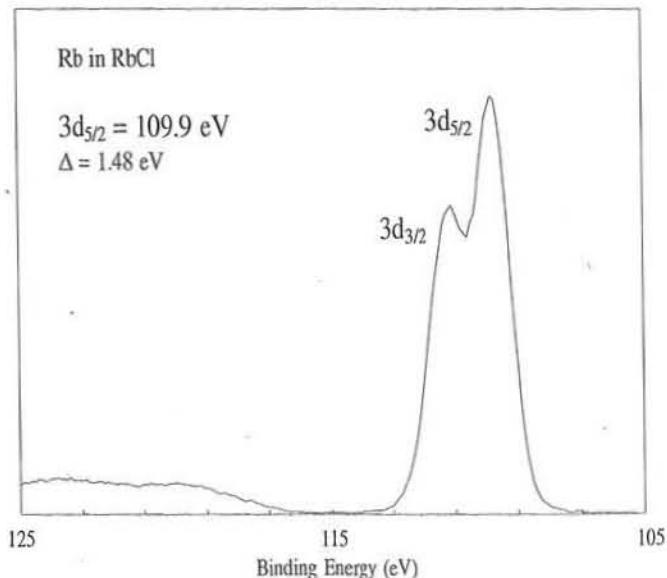
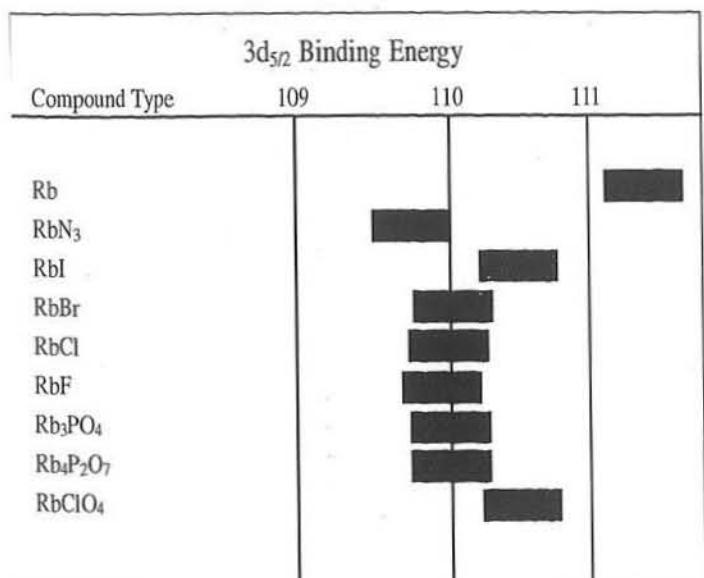
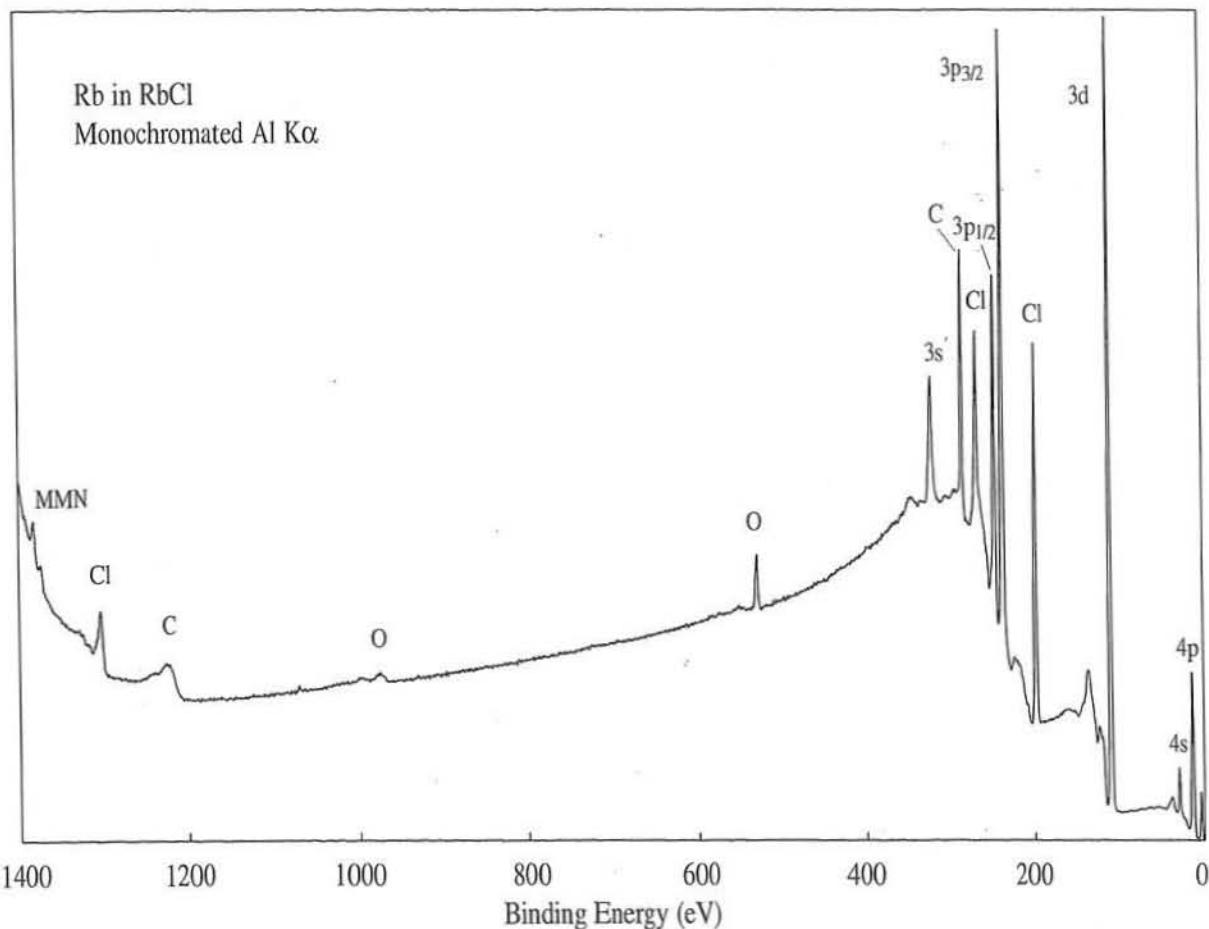
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p
325	249	240	113	111	31	16

---

Auger Lines

M <sub>23</sub> M <sub>45</sub> N <sub>23</sub>
1385
1152

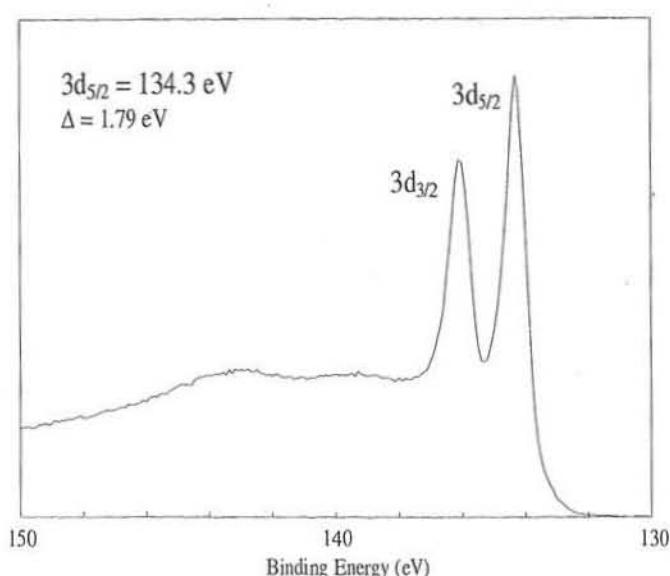
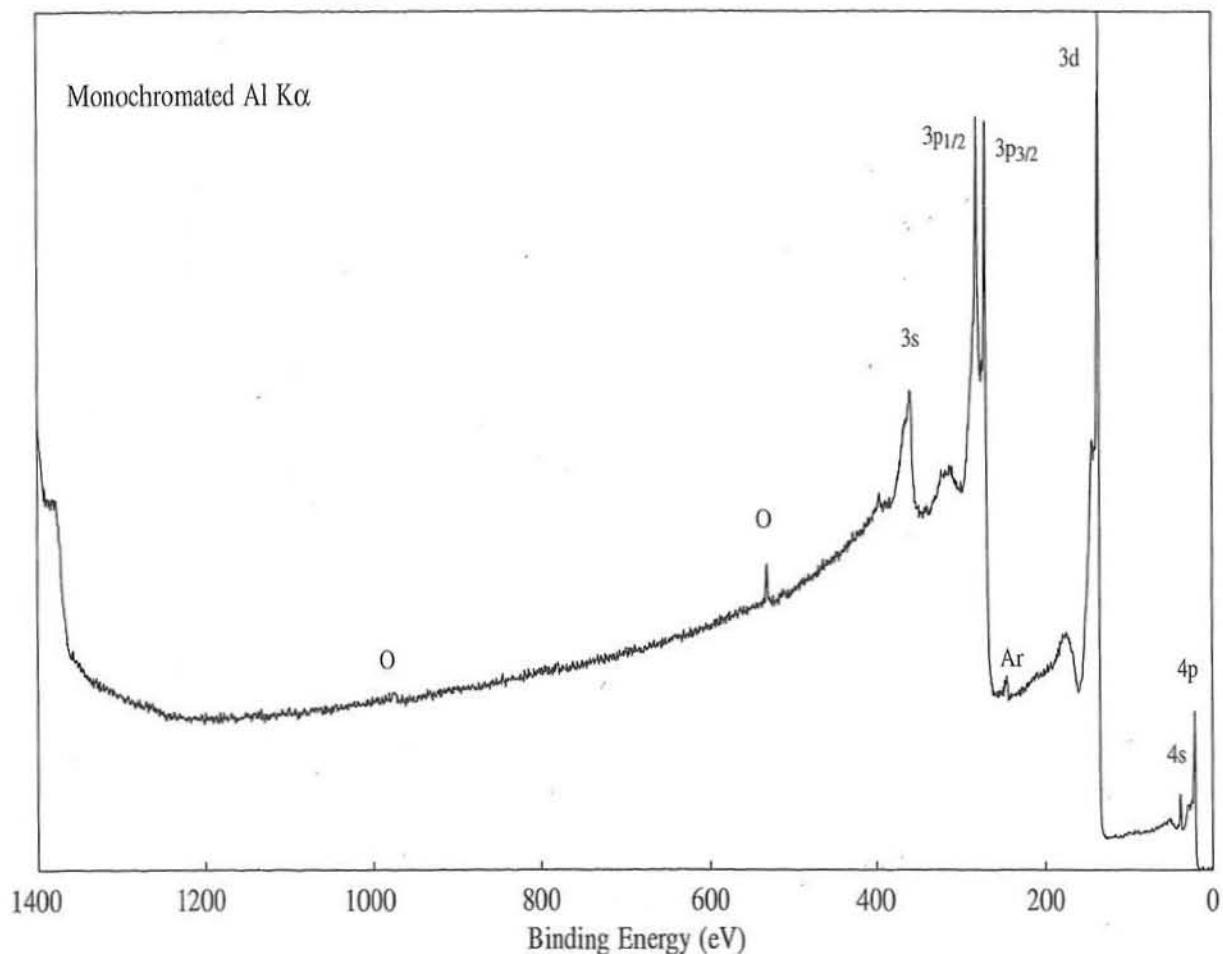
Detailed description: This table lists the binding energies of various photoelectron and auger lines for Rubidium. The photoelectron lines are listed in two rows: 3s, 3p<sub>1/2</sub>, 3p<sub>3/2</sub>, 3d<sub>3/2</sub>, 3d<sub>5/2</sub>, 4s, and 4p. The auger lines are listed in a single column: M<sub>23</sub>M<sub>45</sub>N<sub>23</sub> at 1385 eV and 1152 eV.



# Strontium Sr

Atomic Number 38

## Handbook of X-ray Photoelectron Spectroscopy



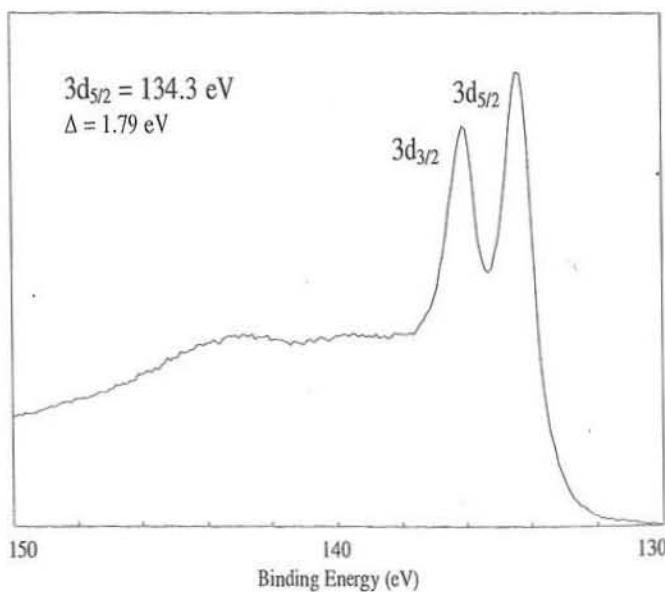
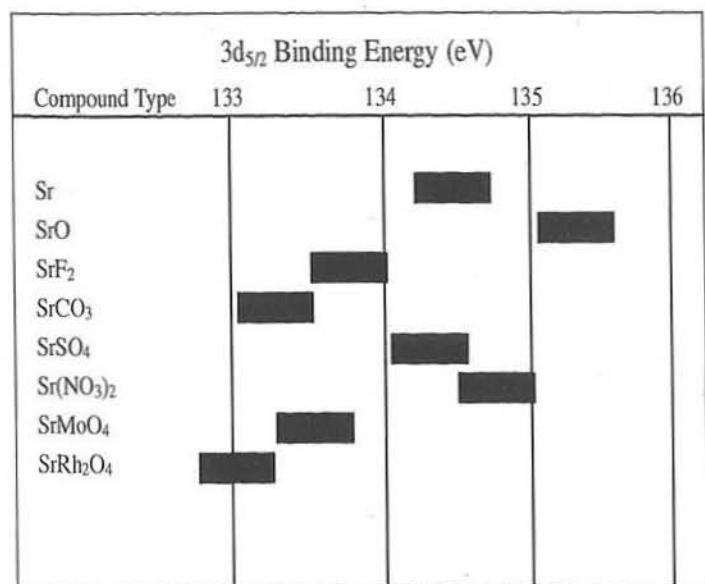
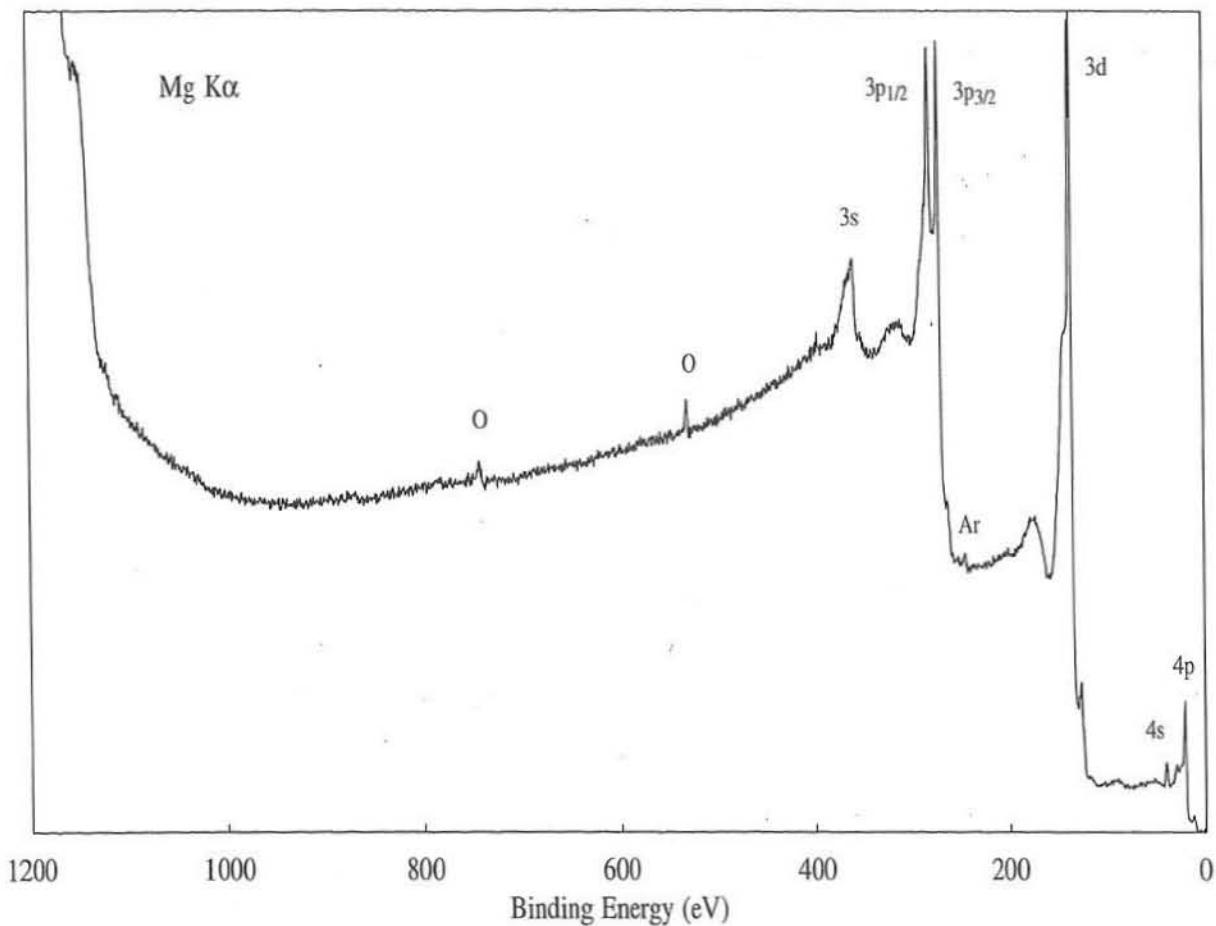
Line Positions (eV)

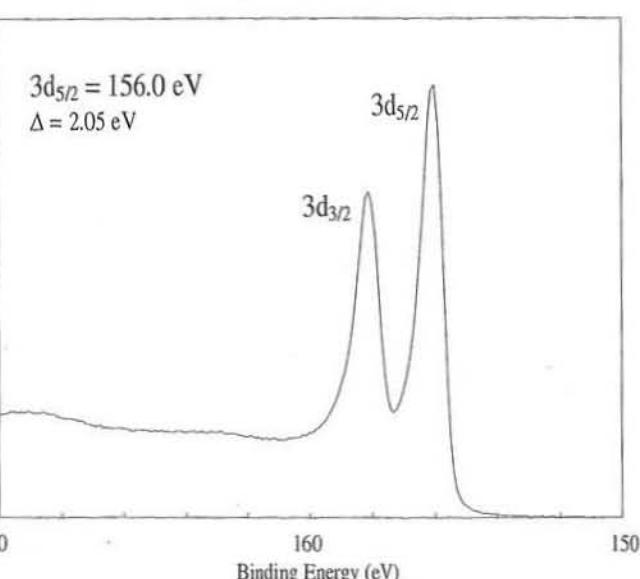
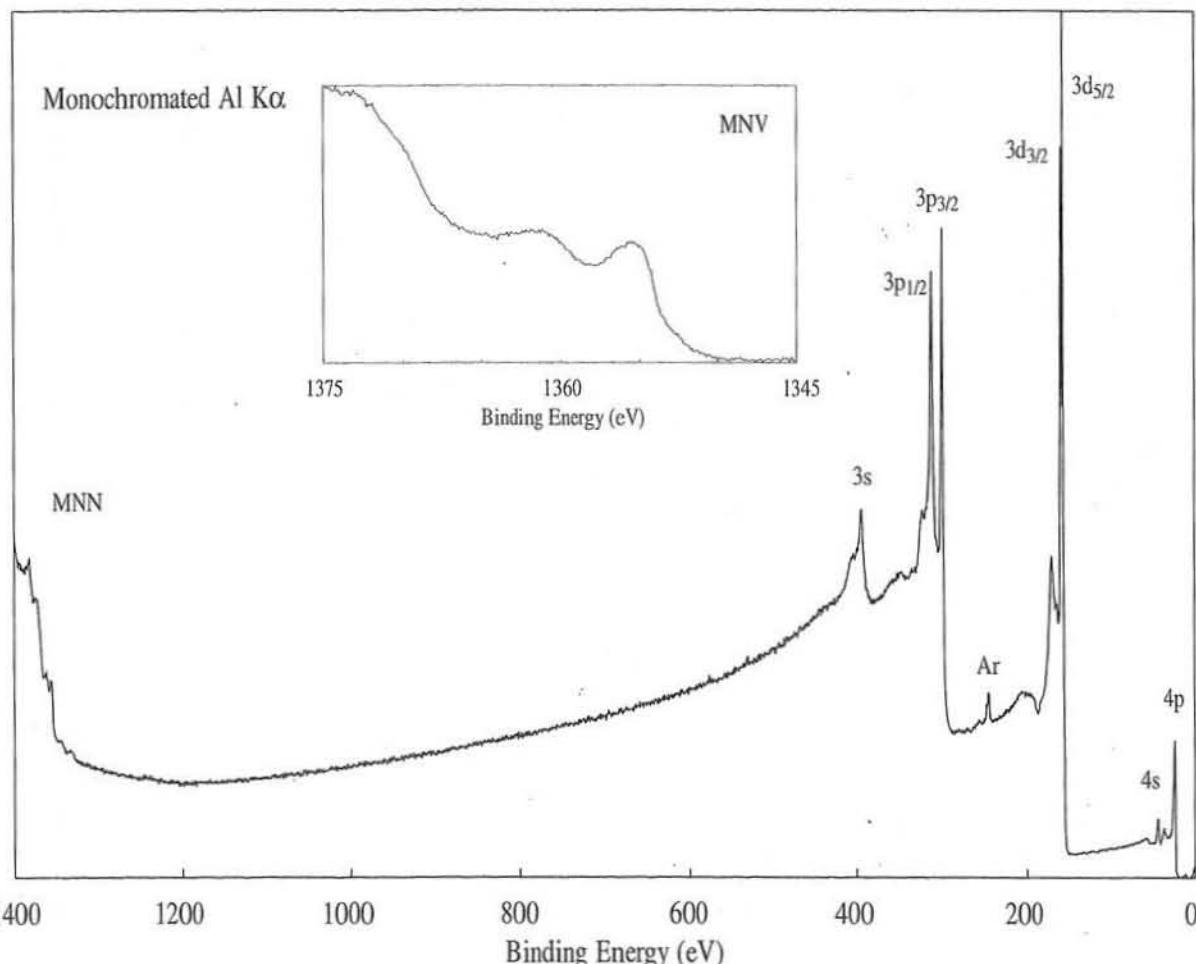
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Photoelectron Lines

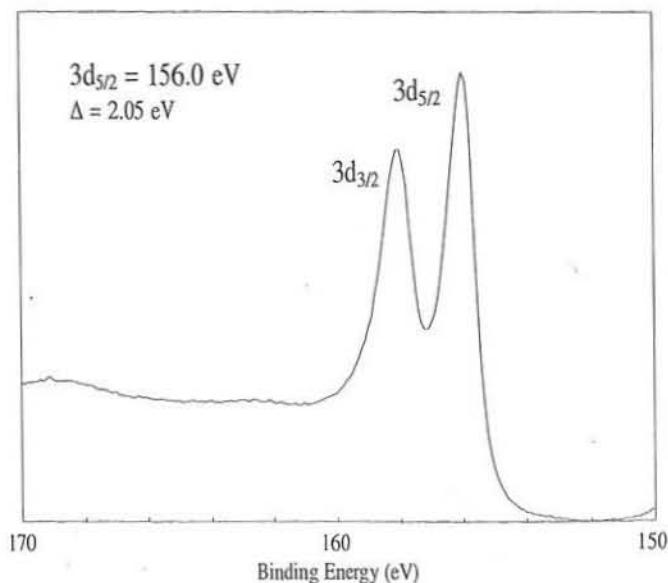
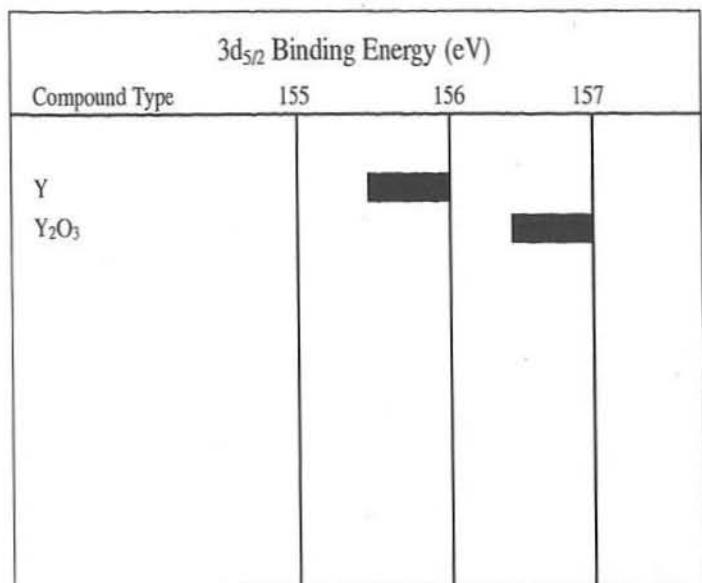
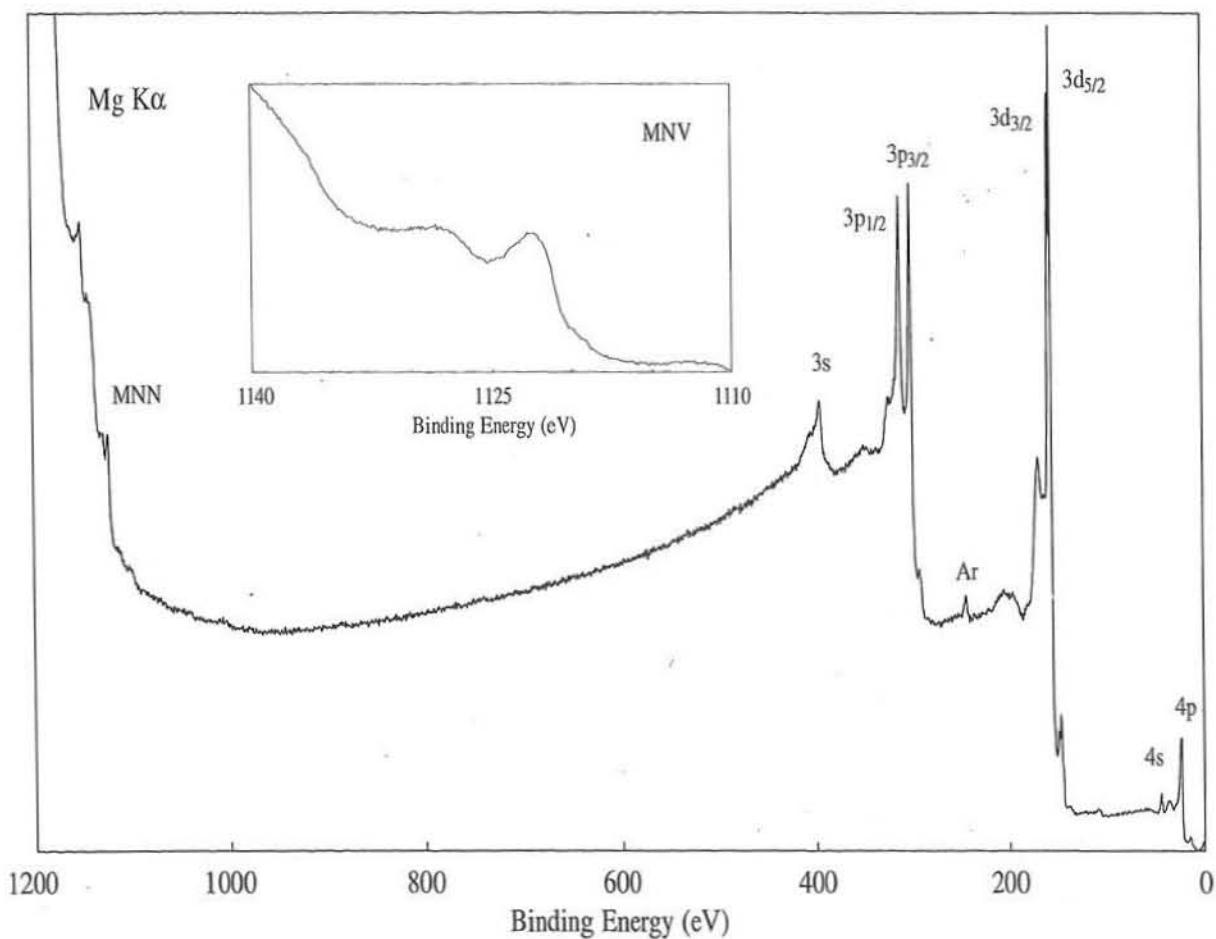
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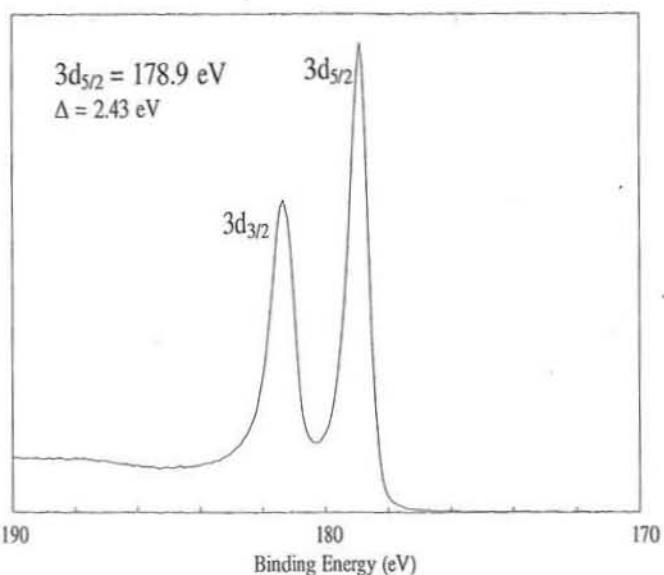
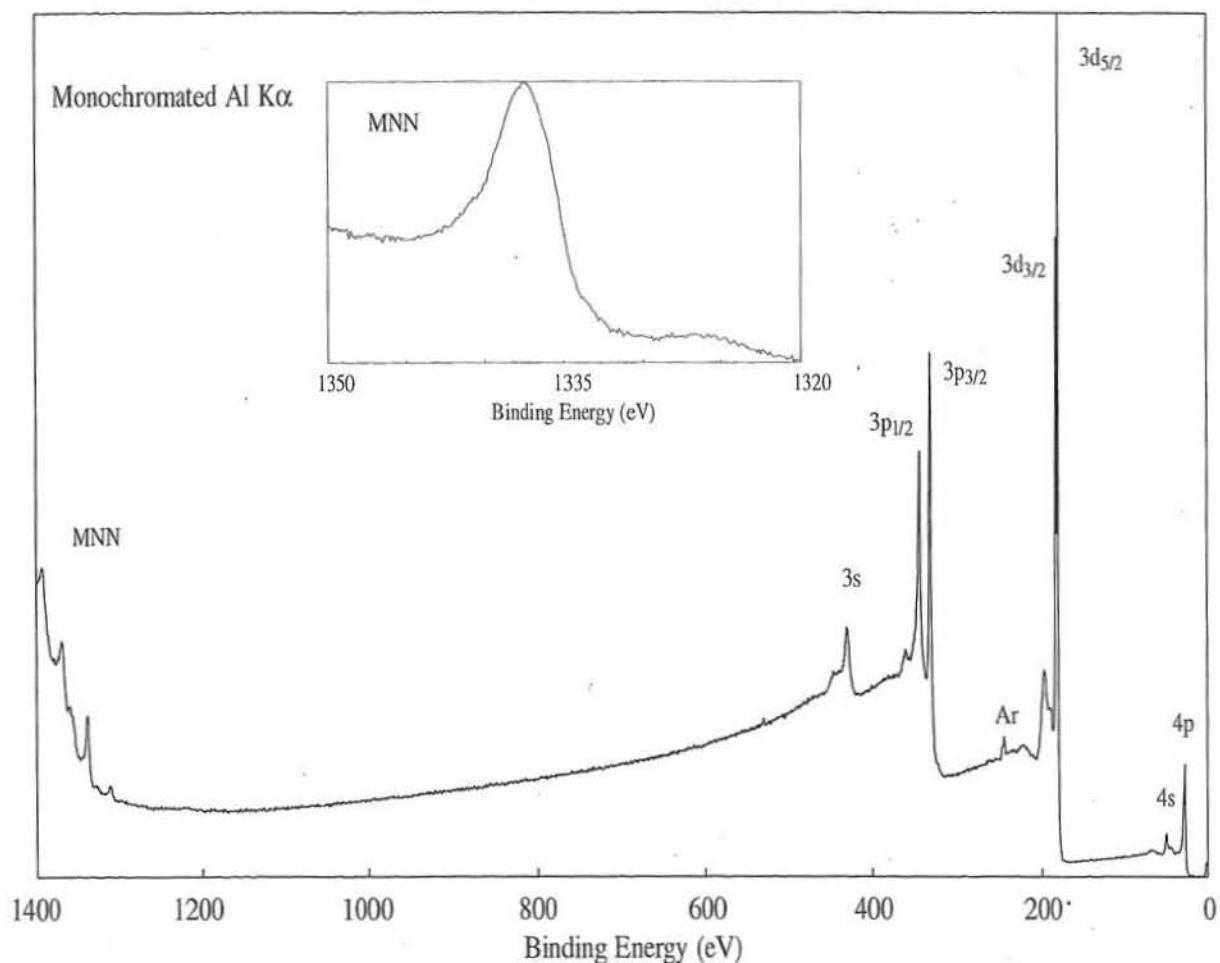
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p
360	281	270	136	134	39	21



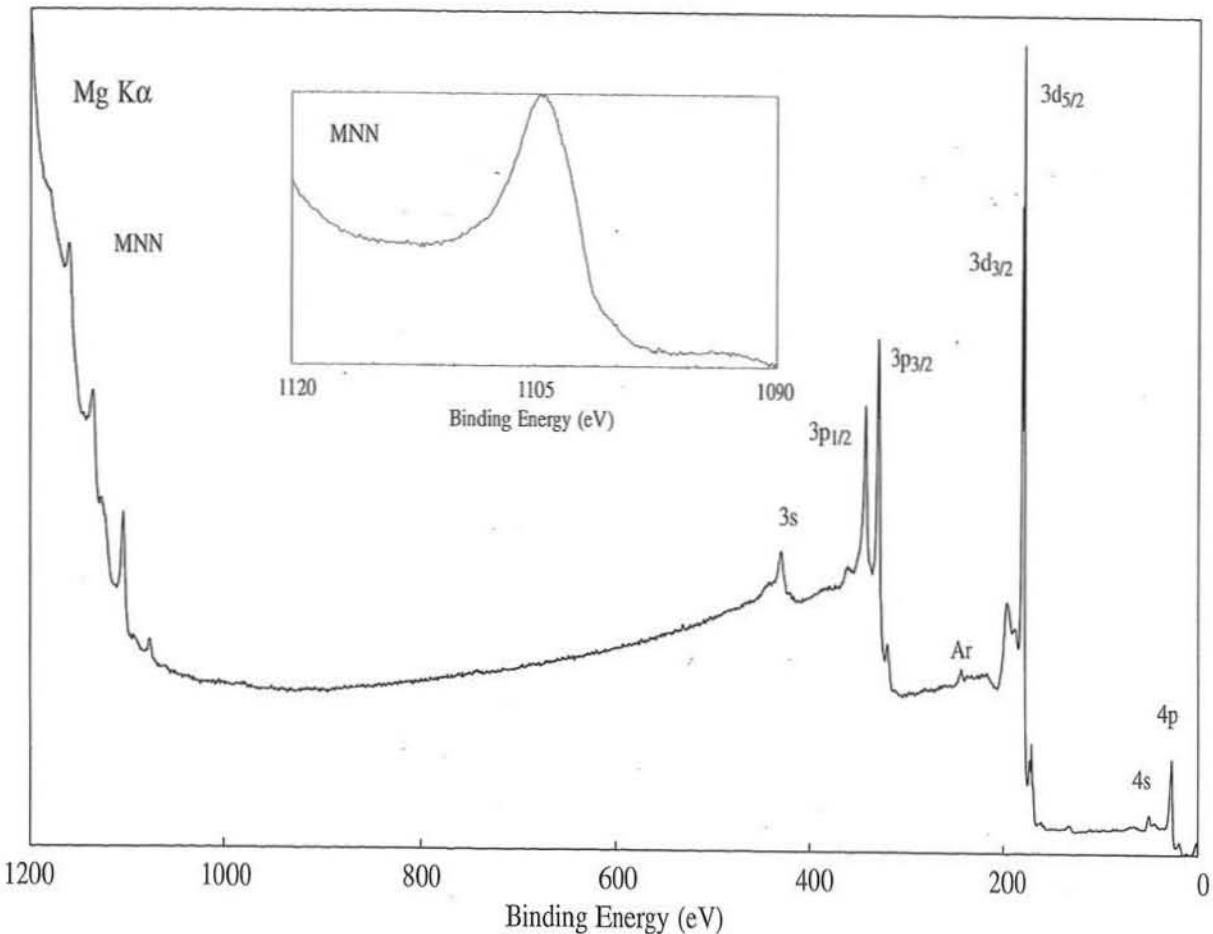


Line Positions (eV)						
Photoelectron Lines						
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p
394	311	299	158	156	45	24
Auger Lines						
M <sub>45</sub> N <sub>23</sub> V						
1356 (Al)						
1123 (Mg)						

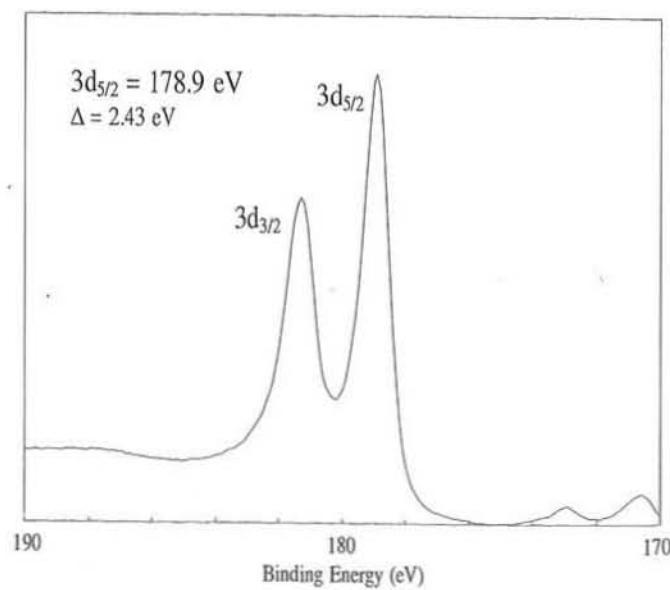


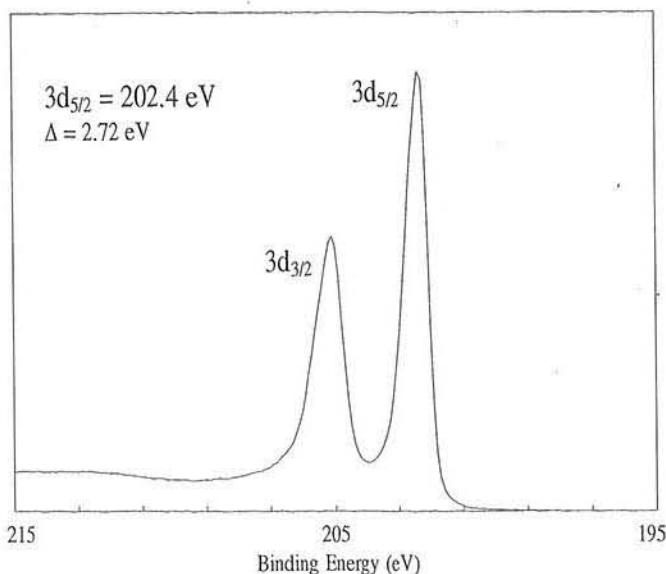
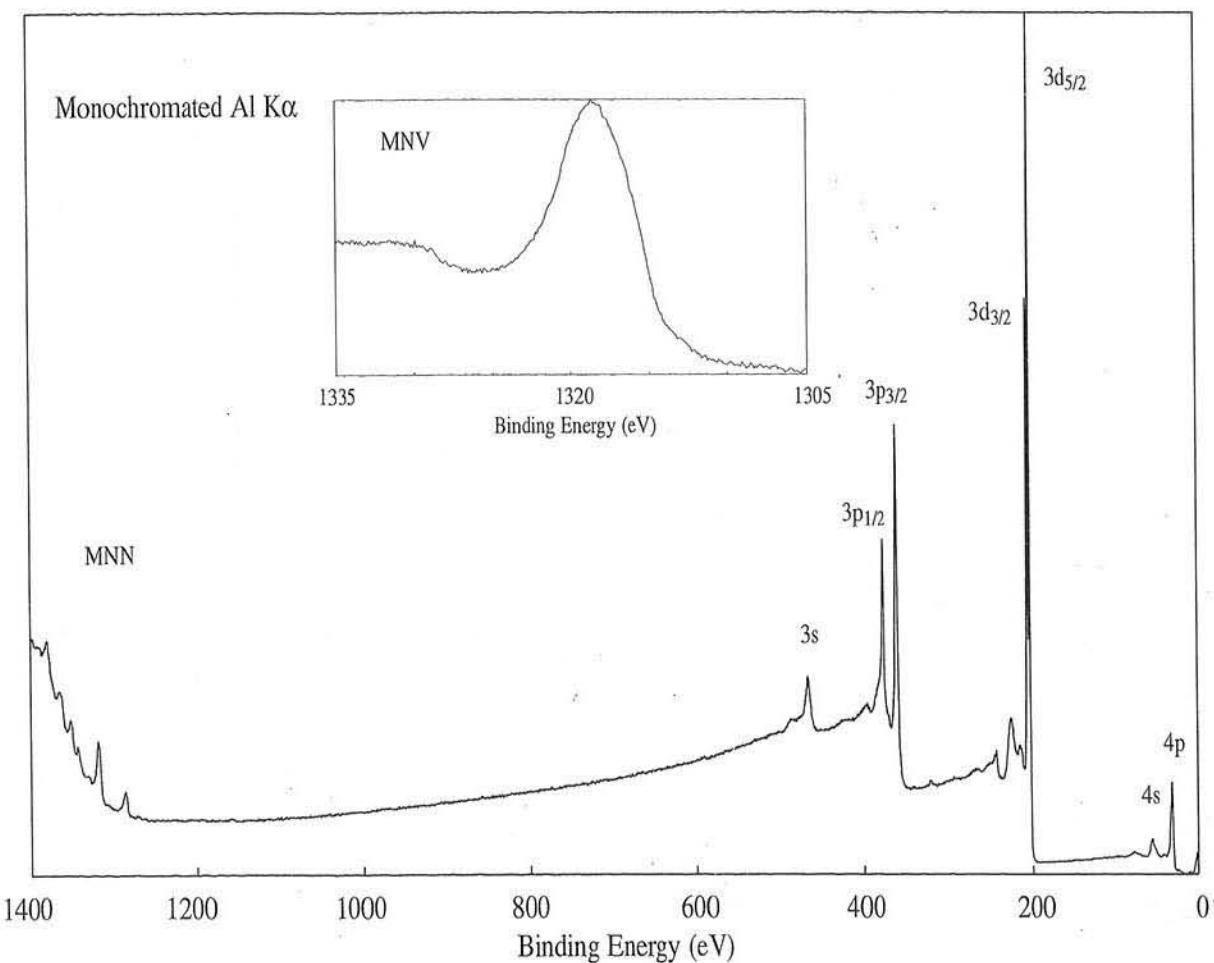


Line Positions (eV)						
Photoelectron Lines						
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p
430	343	330	181	179	51	28
Auger Lines						
M <sub>45</sub> N <sub>23</sub> N <sub>23</sub>		M <sub>45</sub> N <sub>23</sub> V		M <sub>45</sub> N <sub>45</sub> N <sub>45</sub>		
1393		1368		1337	(Al)	
1160		1135		1104	(Mg)	



Compound Type	3d <sub>5/2</sub> Binding Energy (eV)							
	178	179	180	181	182	183	184	185
Zr					■			
ZrO <sub>2</sub>								
ZrF <sub>5</sub>								
K <sub>2</sub> ZrF <sub>6</sub>								
K <sub>3</sub> ZrF <sub>7</sub>					■	■		
KZrF <sub>5</sub> · H <sub>2</sub> O					■	■		





Line Positions (eV)

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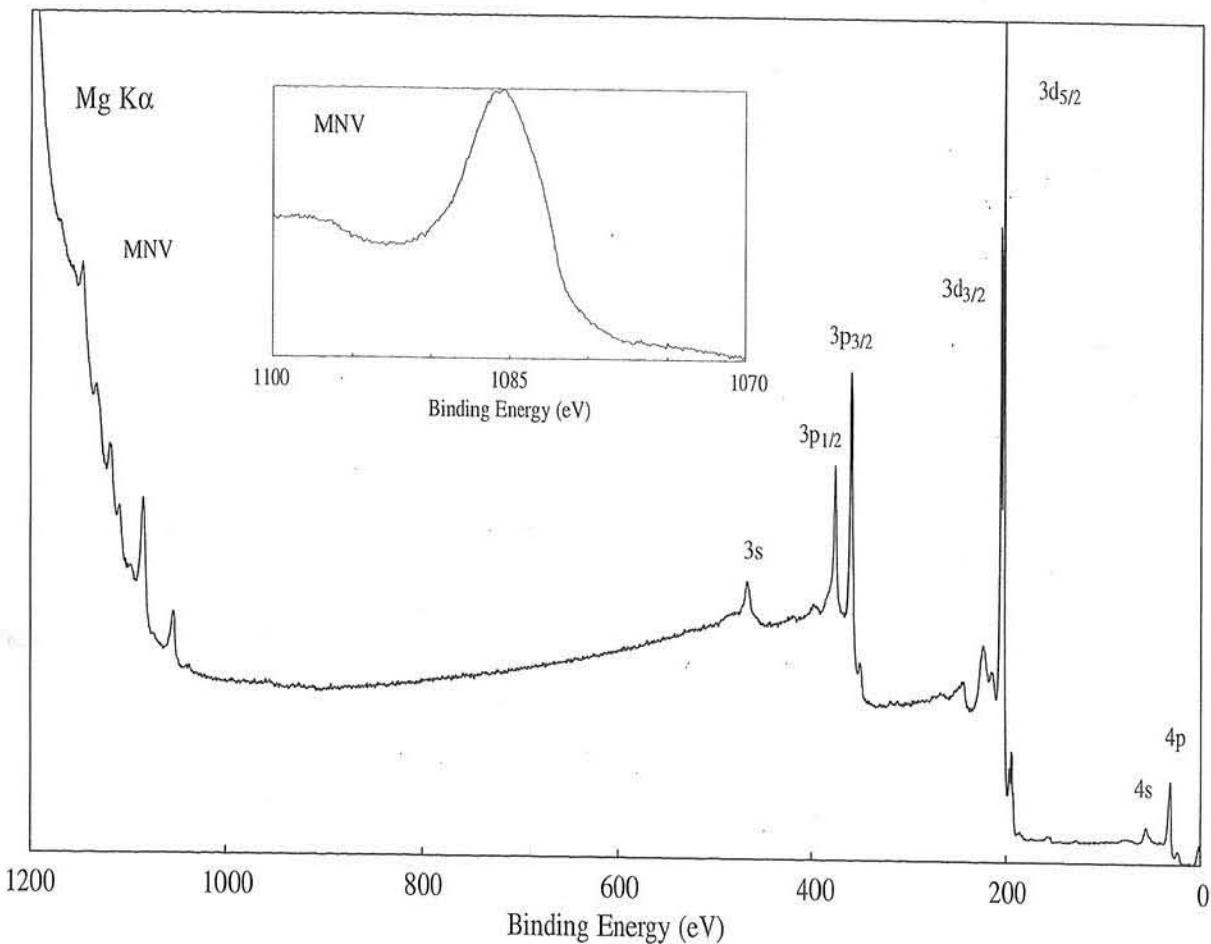
Photoelectron Lines

3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p
467	376	361	205	202	56	31

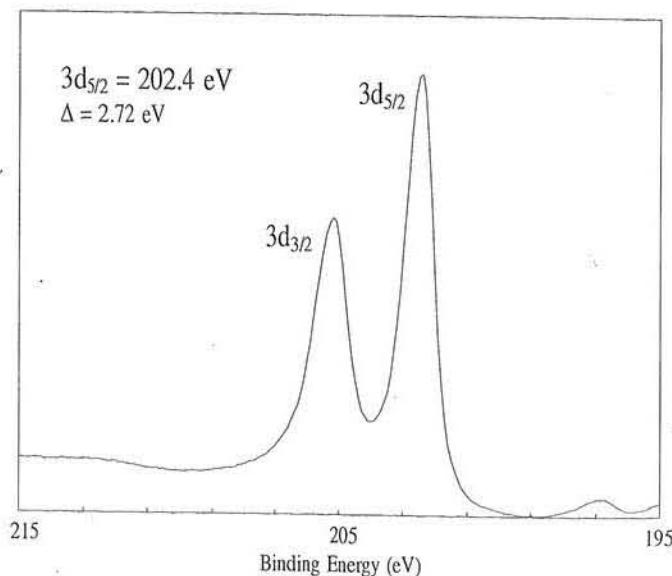
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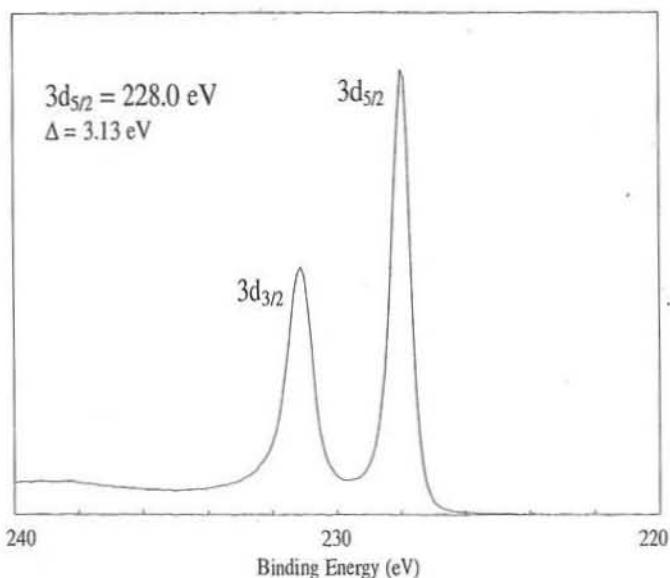
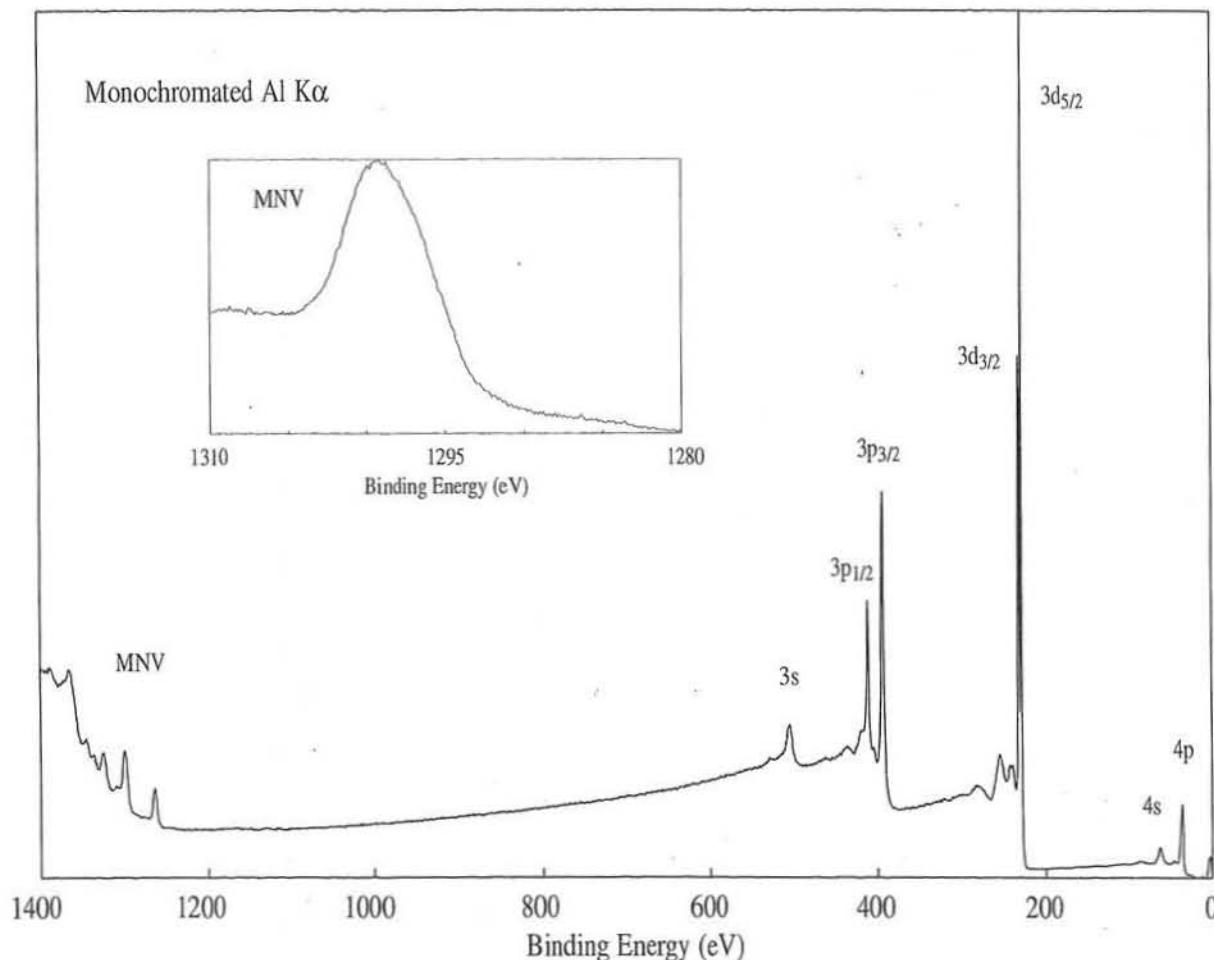
Auger Lines

$M_{45}N_{23}V$	$M_{45}VV$
1319	1287 (Al)
1086	1054 (Mg)



Compound Type	201	202	203	204	205	206	207	208
Nb								
NbN		■						
NbO			■					
Nb <sub>2</sub> O <sub>5</sub>								
LiNbO <sub>3</sub>								
CaNb <sub>2</sub> O <sub>6</sub>								
Ca <sub>2</sub> Nb <sub>2</sub> O <sub>7</sub>								
Br <sub>6</sub> (Nb <sub>6</sub> Cl <sub>12</sub> )(Bu <sub>4</sub> N) <sub>2</sub>				■				
Cl <sub>2</sub> (Nb <sub>6</sub> Cl <sub>12</sub> )(Pr <sub>3</sub> P) <sub>4</sub>				■	■			
Cl <sub>2</sub> (Nb <sub>6</sub> Cl <sub>12</sub> )(Me <sub>2</sub> SO) <sub>4</sub>				■	■			





Line Positions (eV)

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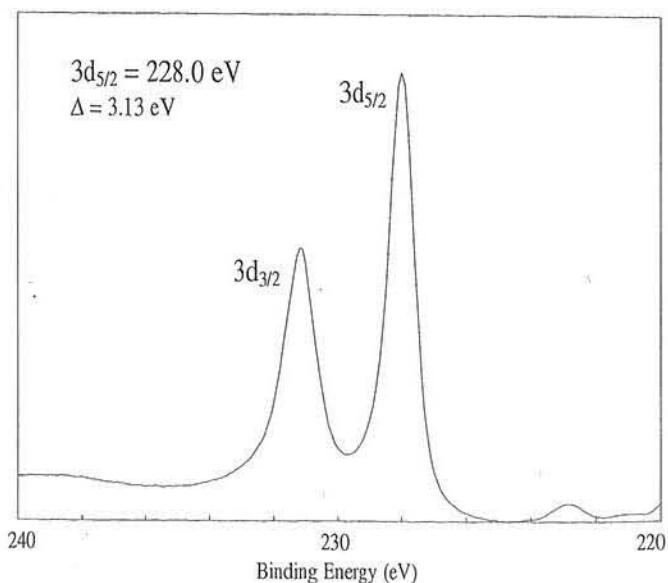
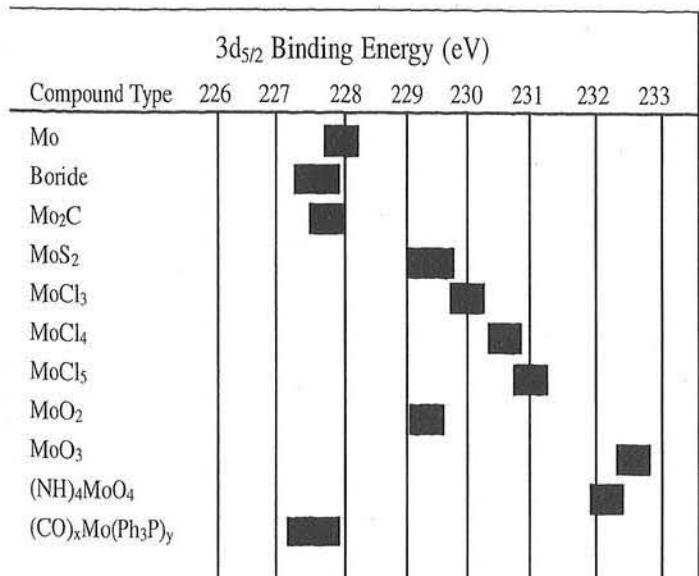
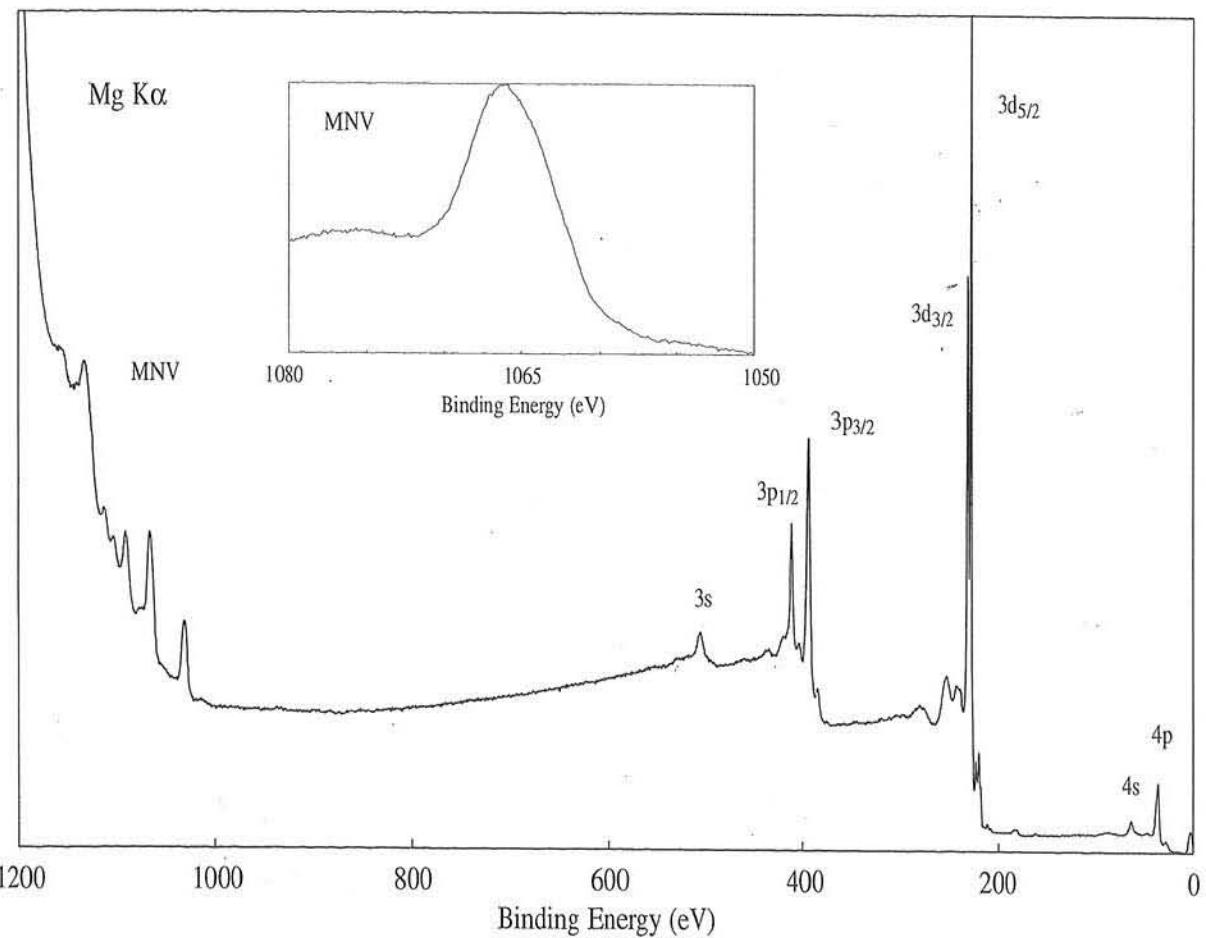
Photoelectron Lines

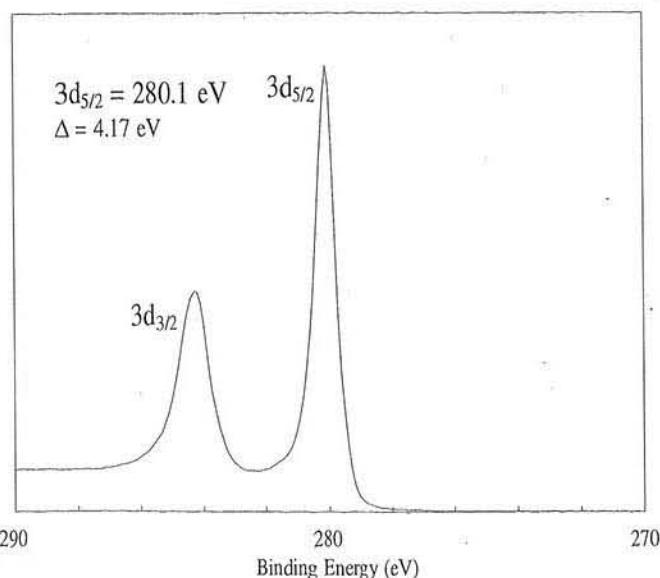
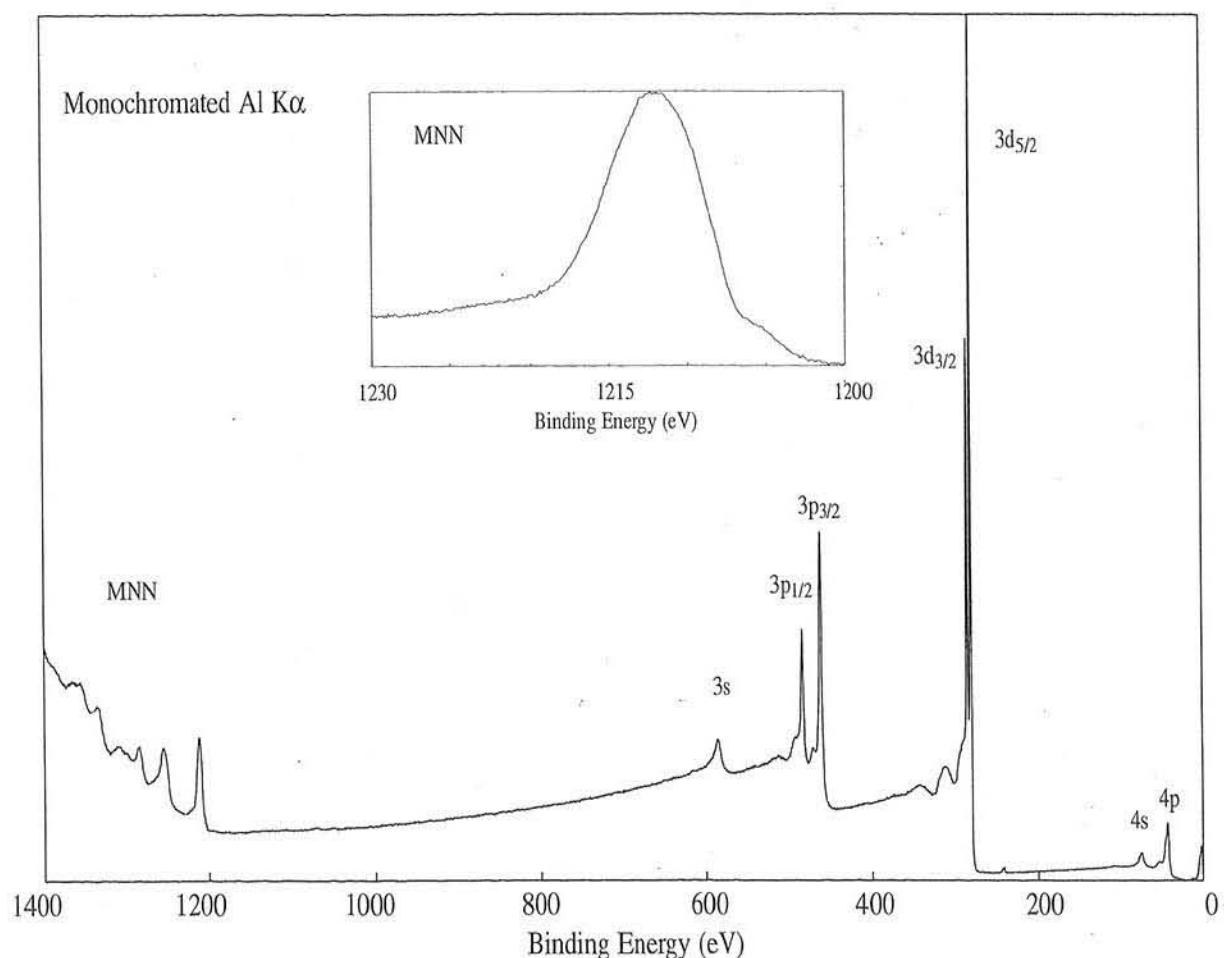
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p
506	412	394	231	228	63	36

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Auger Lines

M <sub>45</sub> N <sub>23</sub> V	M <sub>45</sub> VV
1299	1264 (Al)
1066	1031 (Mg)





Line Positions (eV)

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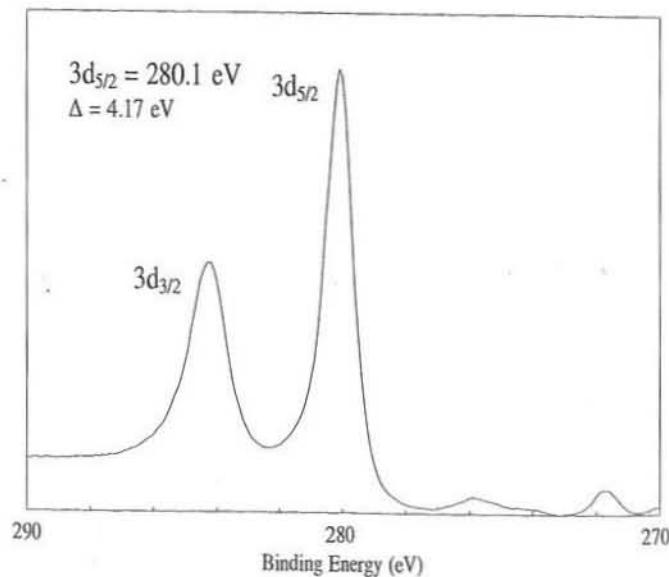
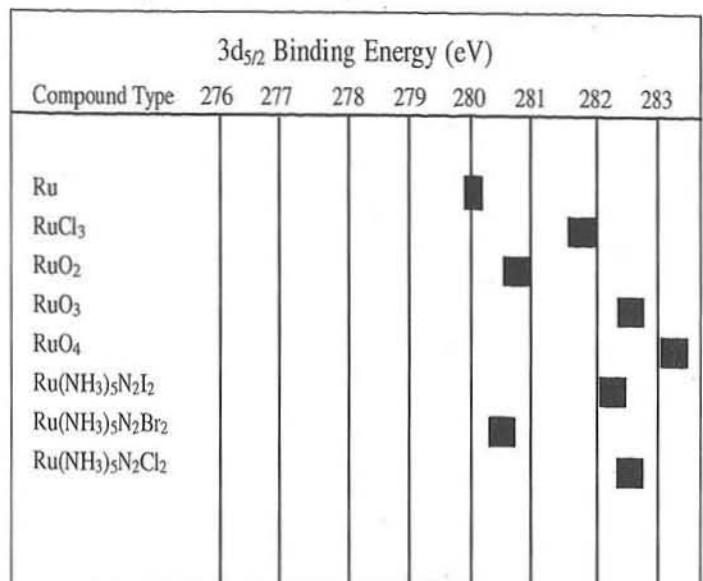
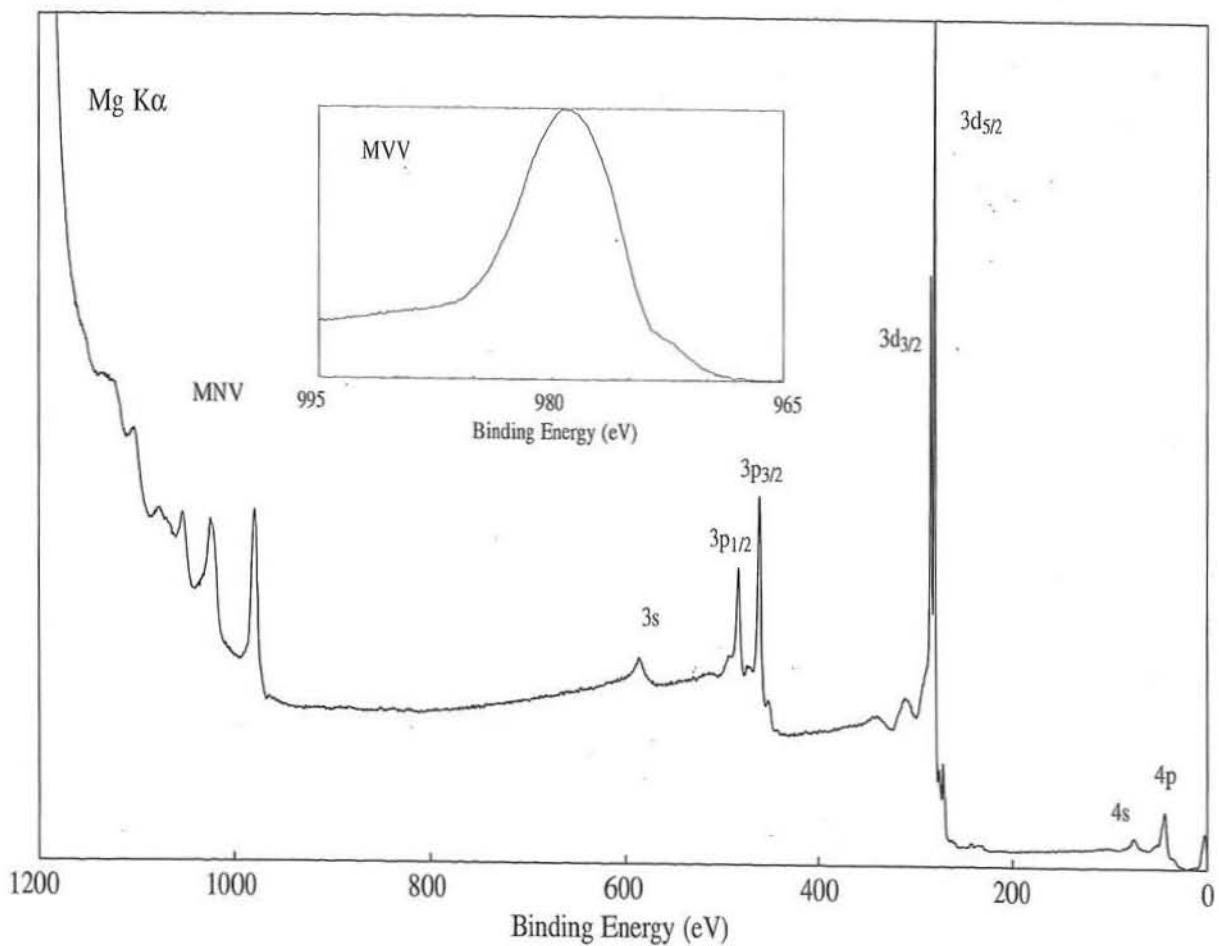
Photoelectron Lines

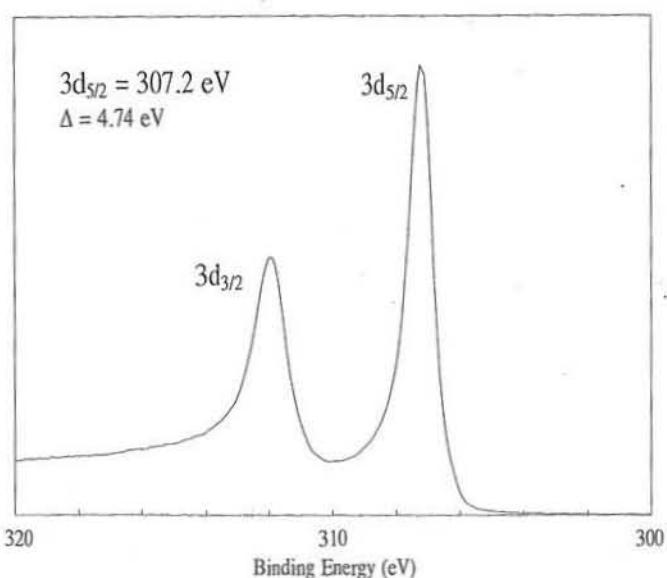
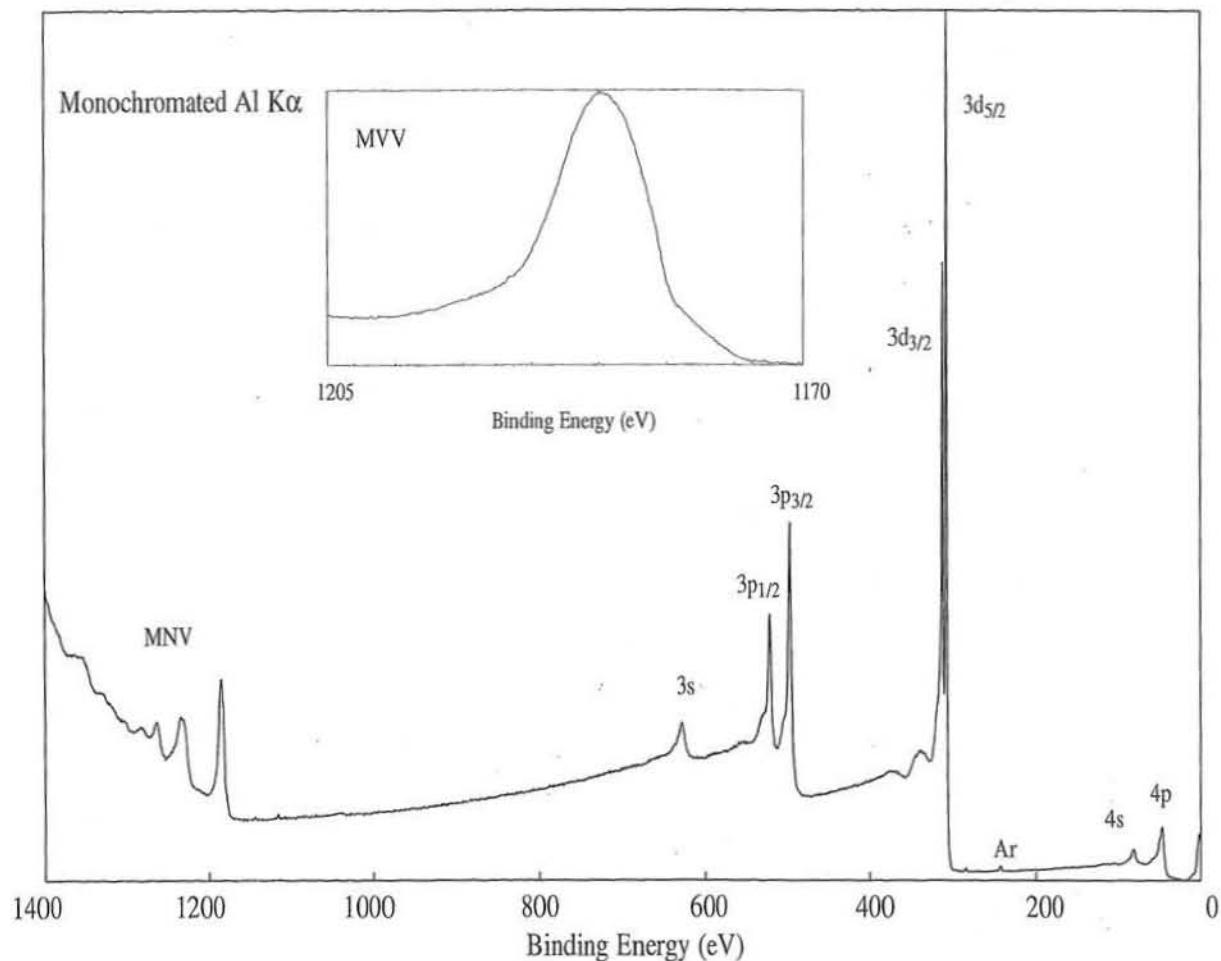
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p
586	484	462	284	280	75	43

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Auger Lines

M <sub>45</sub> N <sub>23</sub> V	M <sub>45</sub> VV
1256	1212 (Al)
1023	979 (Mg)





Line Positions (eV)

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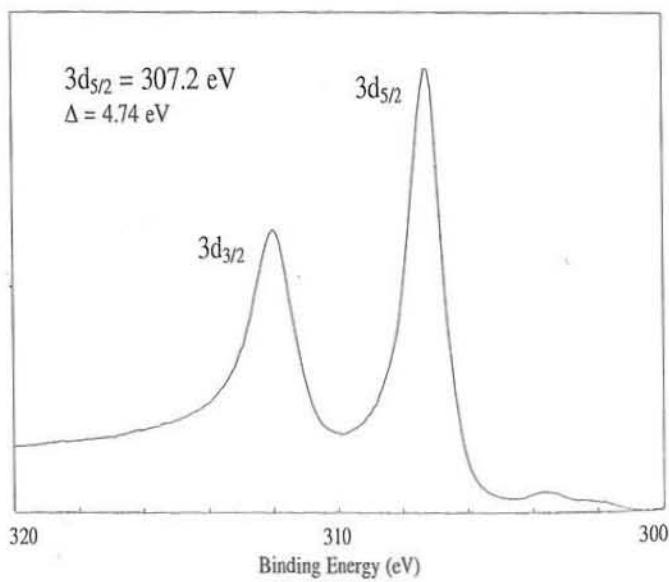
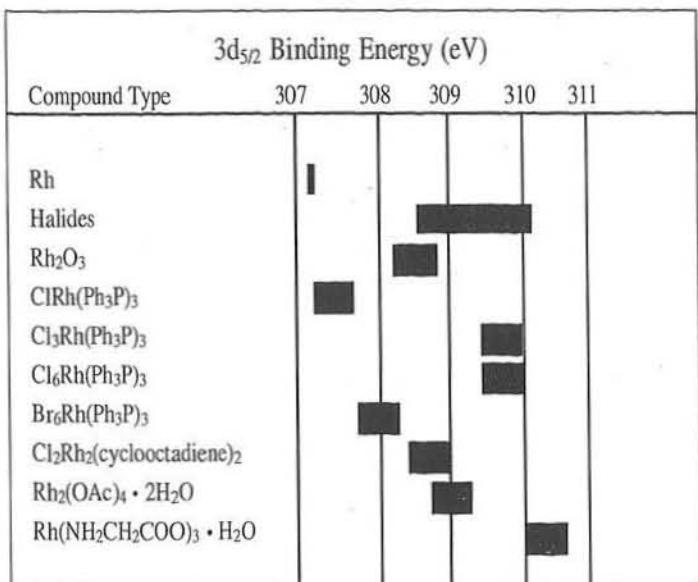
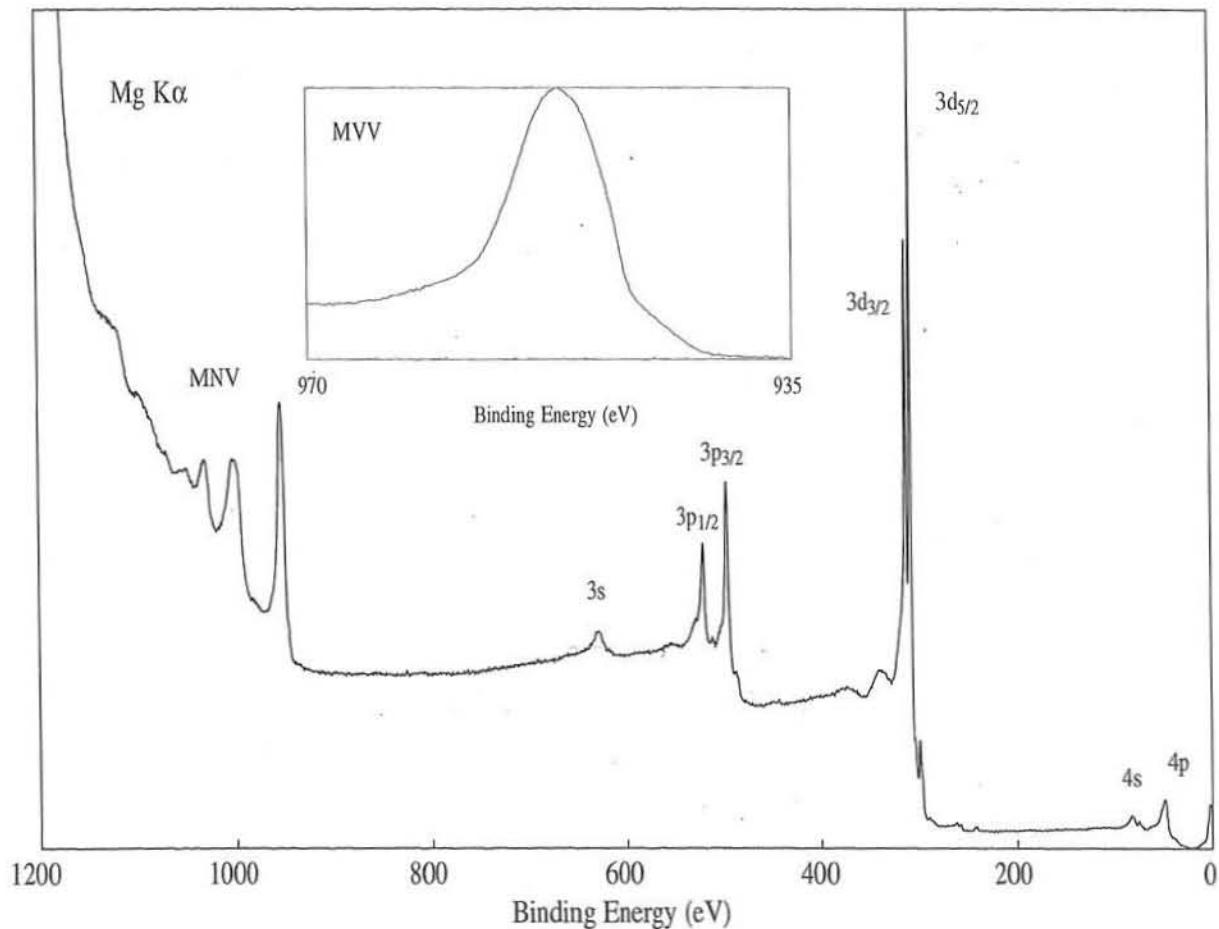
Photoelectron Lines

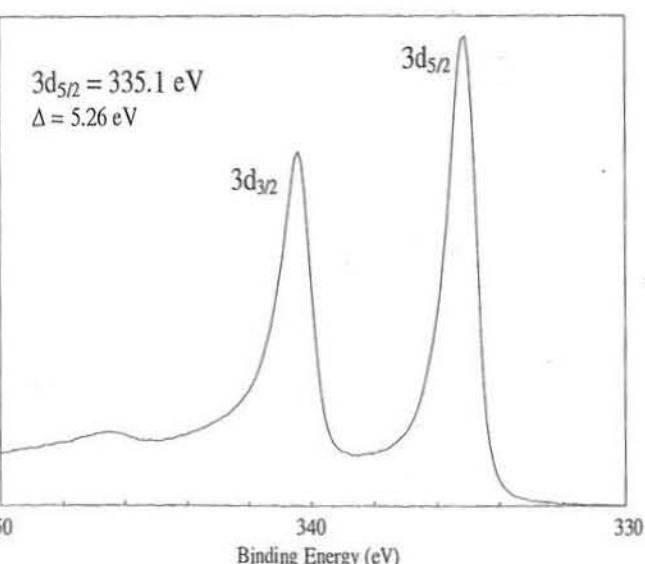
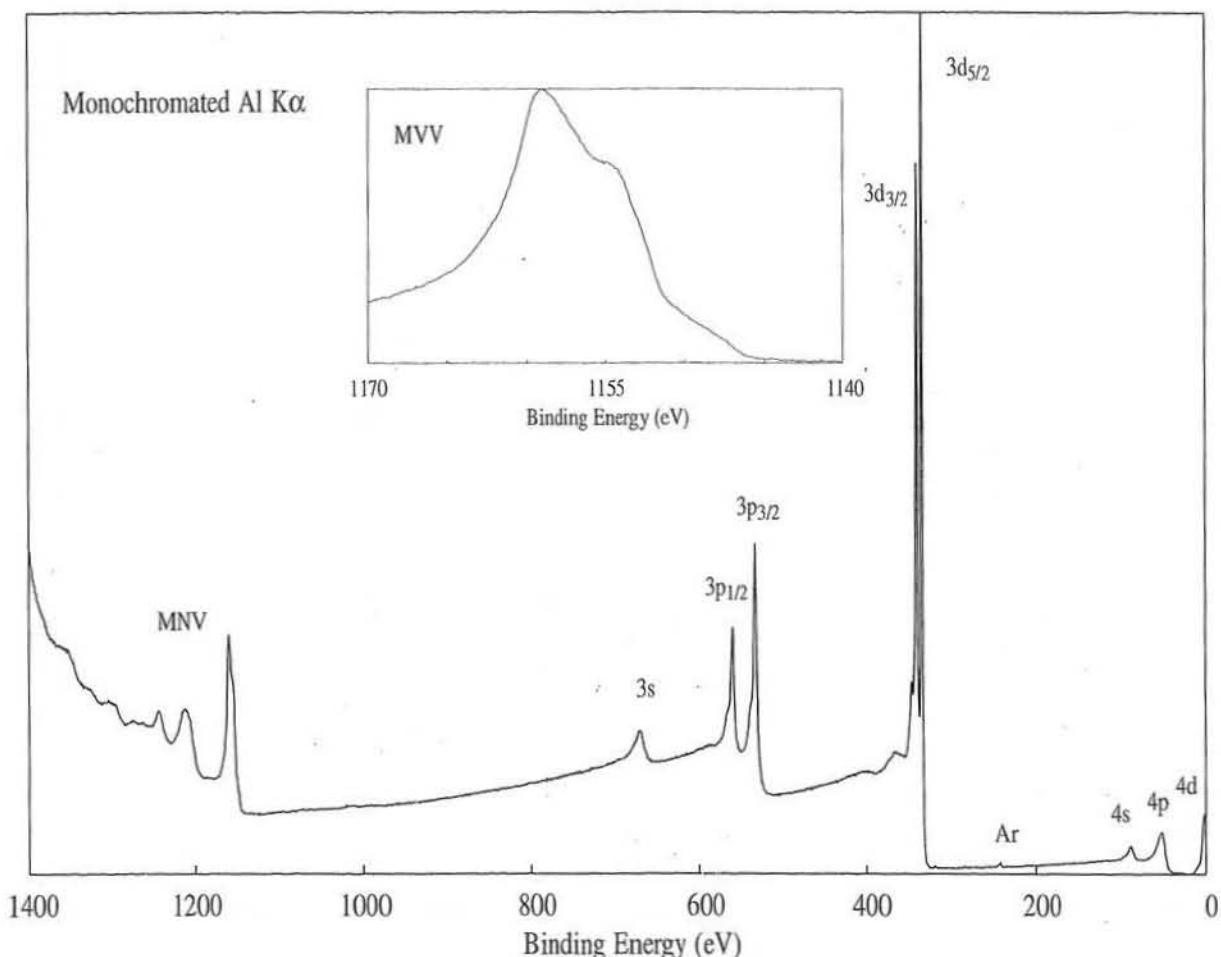
3s	3p $_{1/2}$	3p $_{3/2}$	3d $_{3/2}$	3d $_{5/2}$	4s	4p
629	521	497	312	307	81	48

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Auger Lines

$M_{45}N_{23}V$	$M_{45}VV$
1234	1185 (Al)
1001	952 (Mg)





Line Positions (eV)

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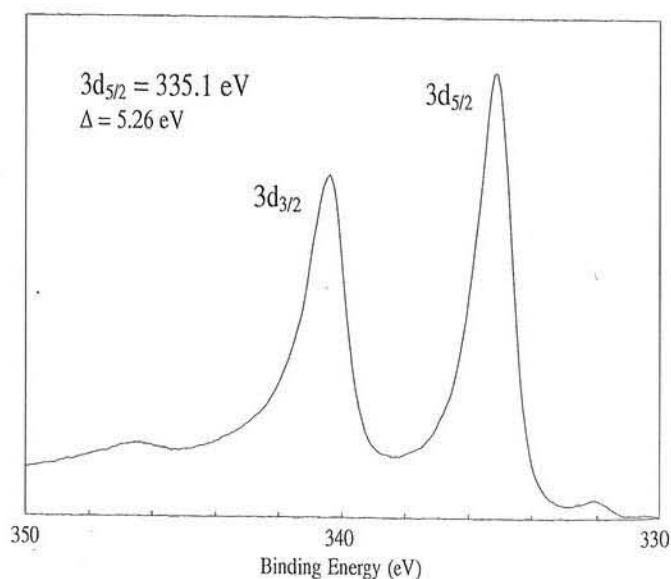
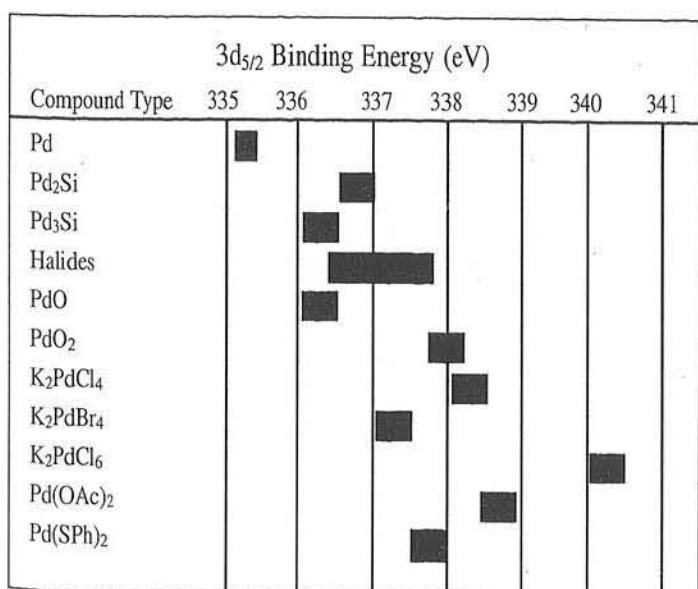
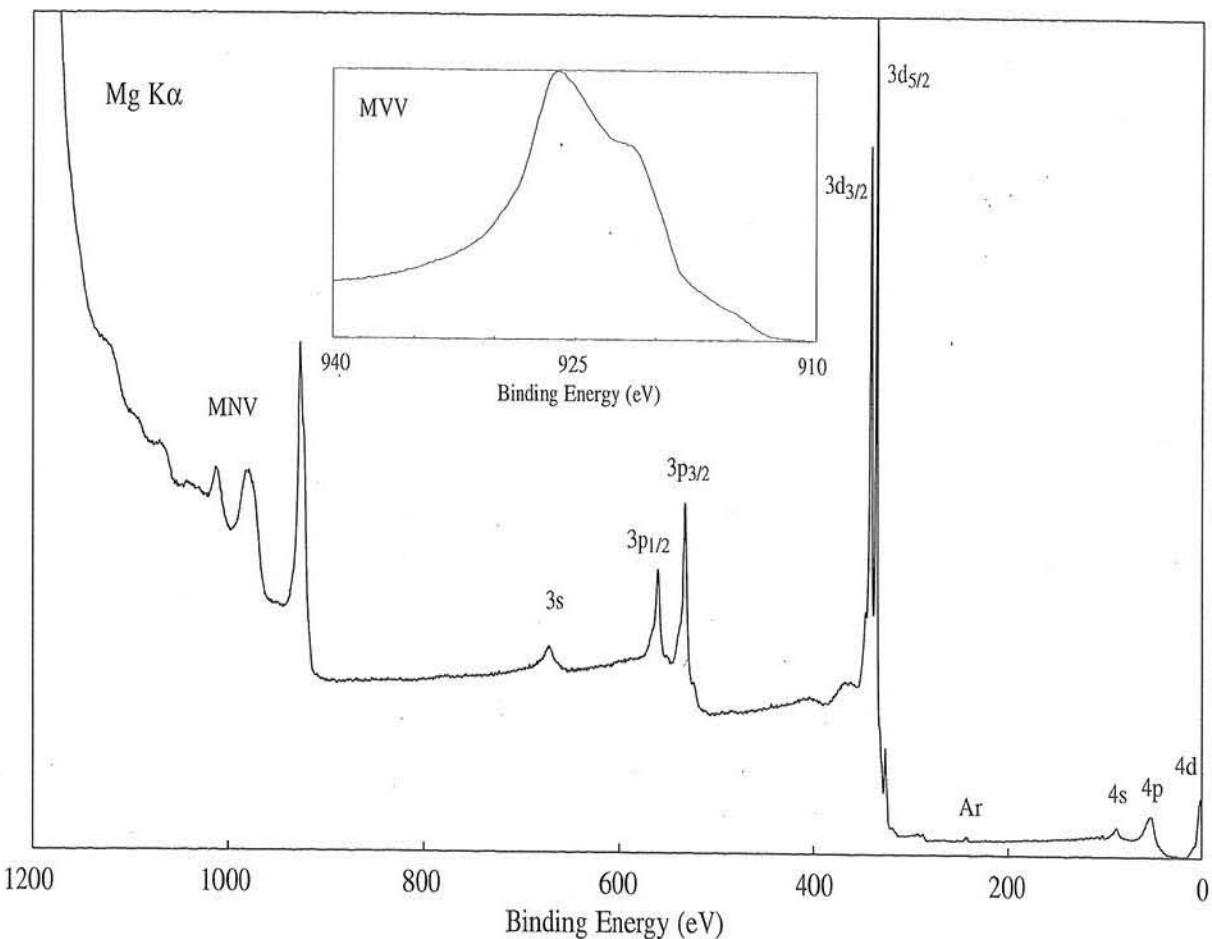
Photoelectron Lines

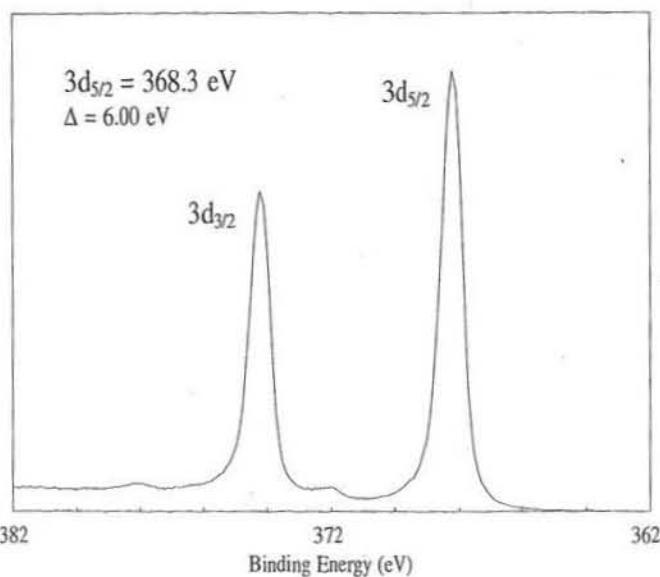
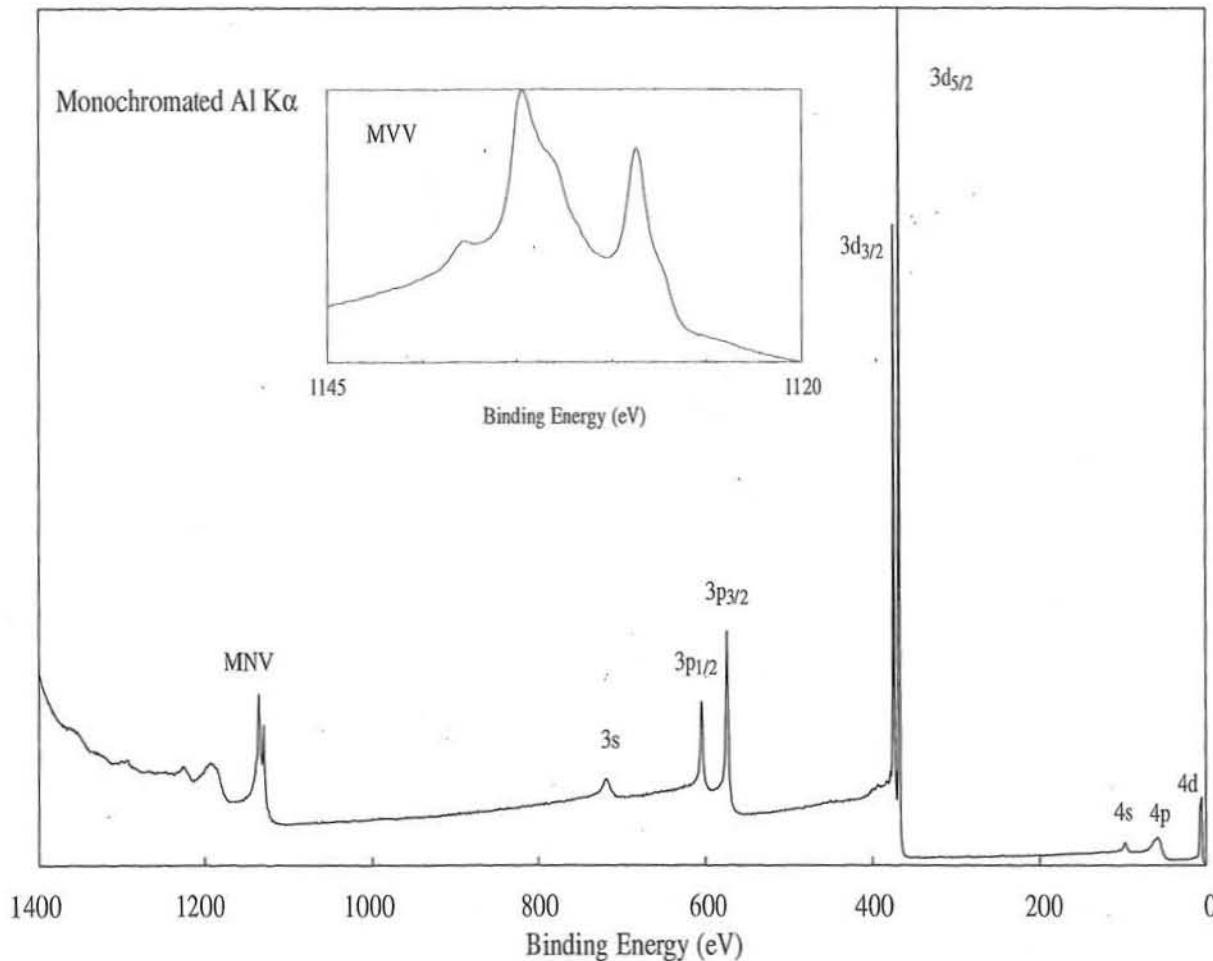
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p
671	560	533	340	335	88	52

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Auger Lines

$M_{45}N_{23}V$	$M_{45}VV$
1211	1159 (Al)
978	926 (Mg)





Line Positions (eV)

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Photoelectron Lines

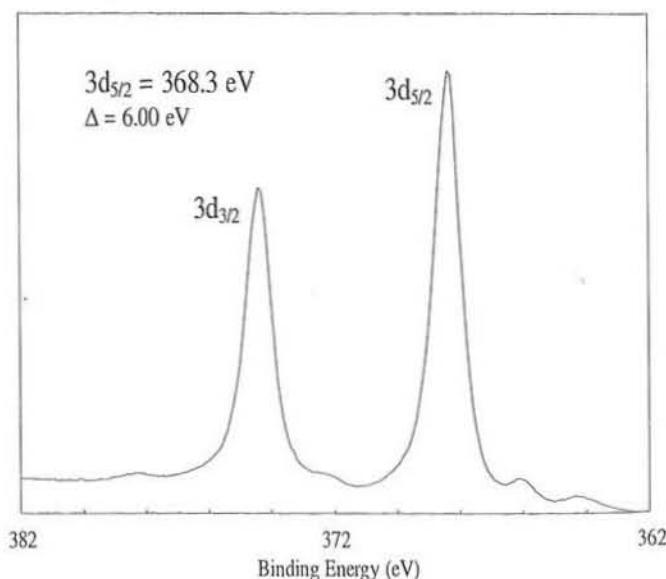
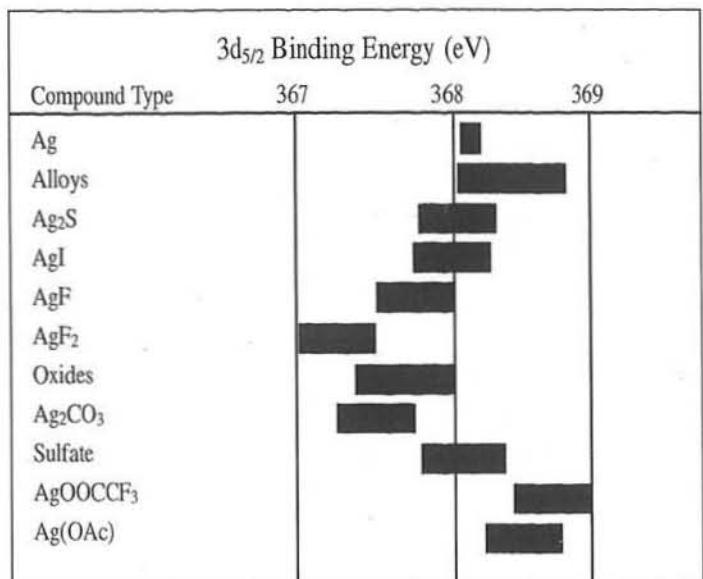
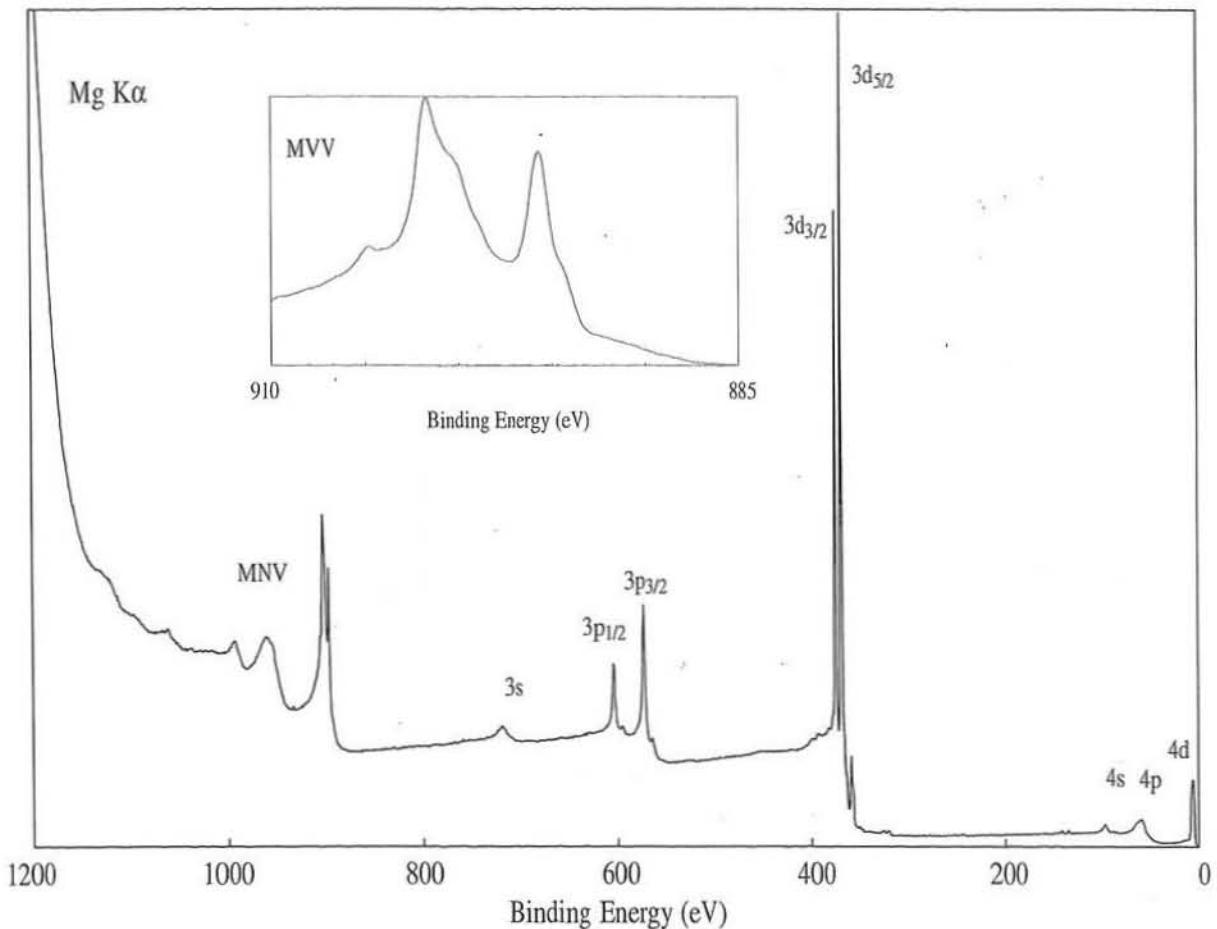
3s	3p $_{1/2}$	3p $_{3/2}$	3d $_{3/2}$	3d $_{5/2}$	4s	4p
719	604	573	374	368	98	60

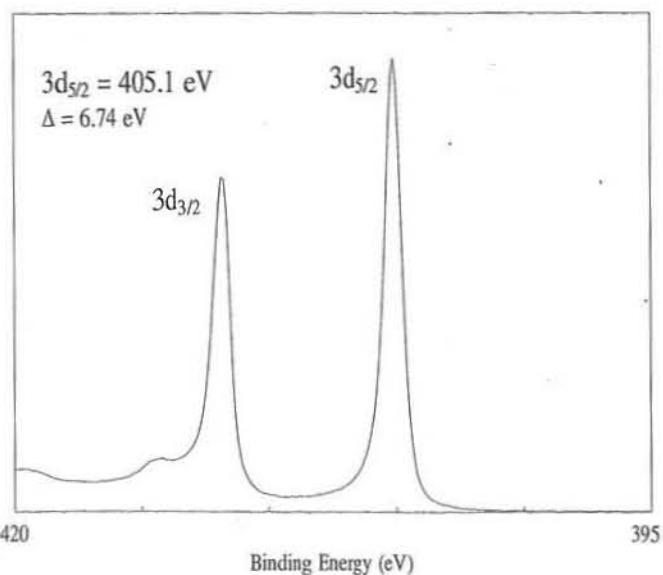
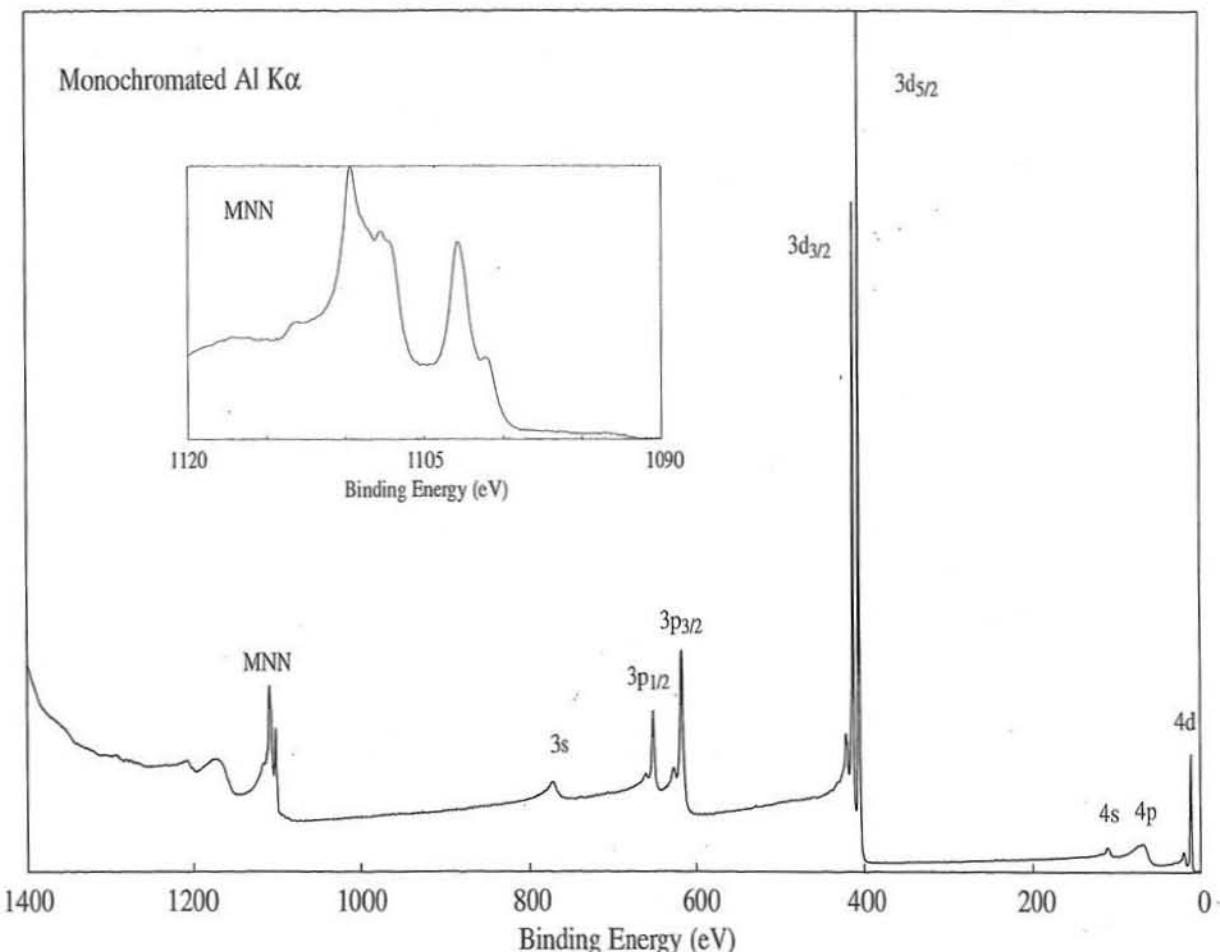
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Auger Lines

$M_{45}N_{23}V$	$M_5VV$	$M_4VV$
1191	1135	1129
958	902	(Al)
		(Mg)







Line Positions (eV)

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Photoelectron Lines

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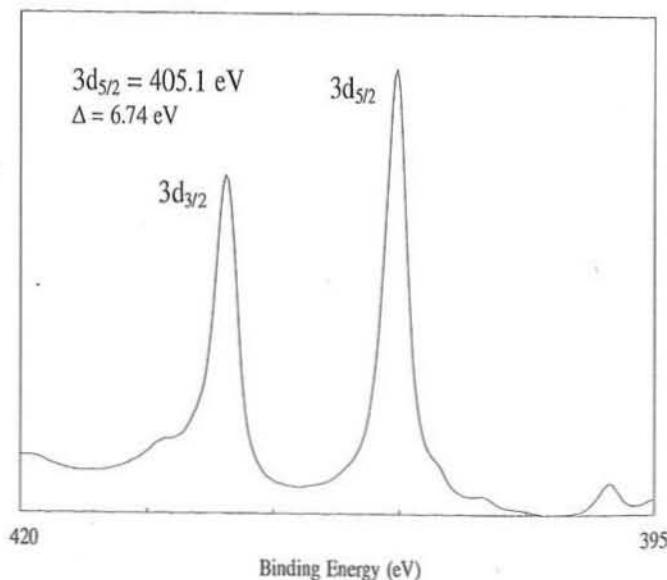
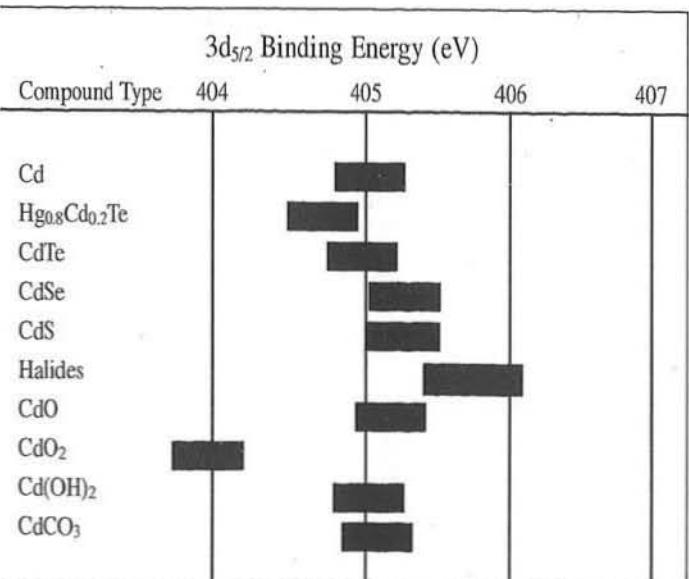
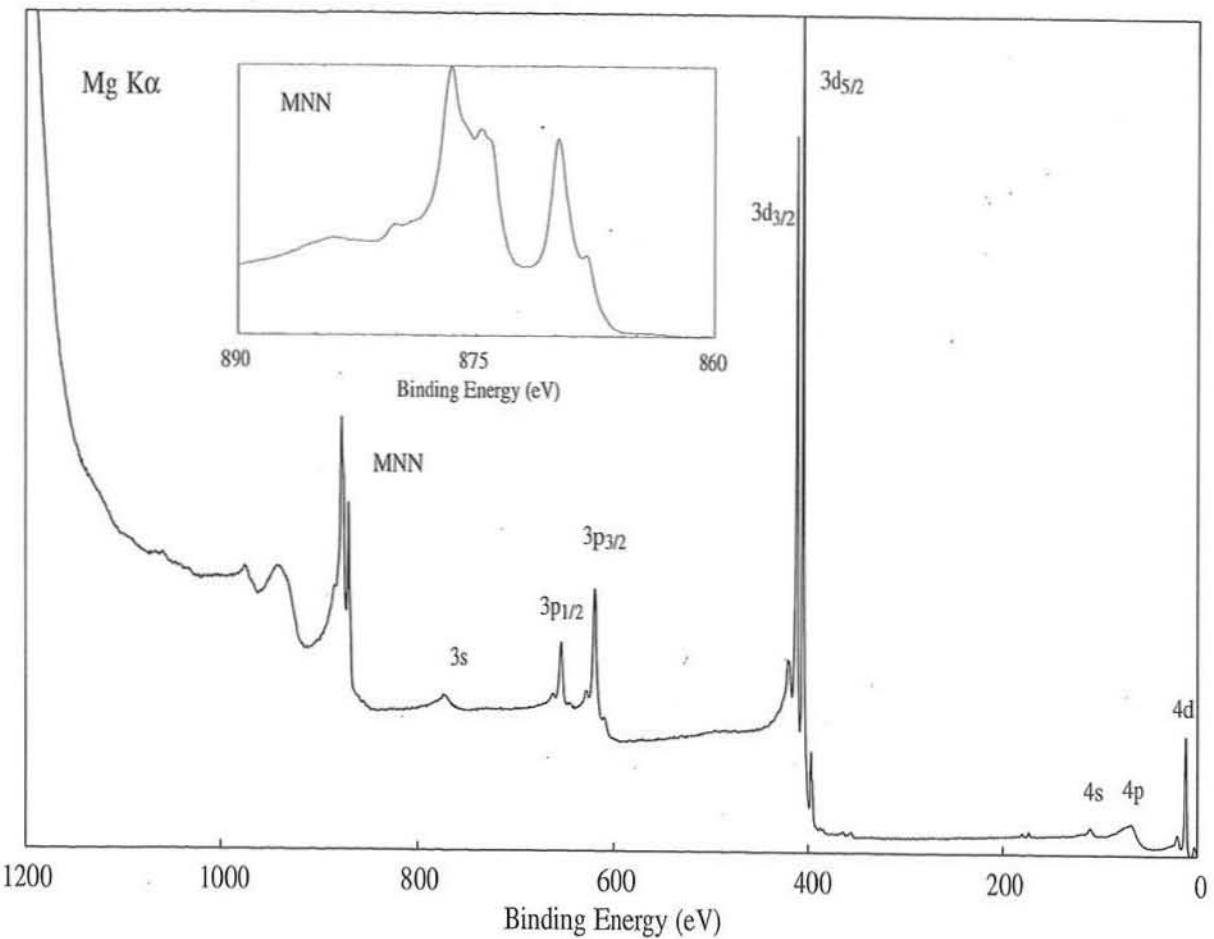
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p	4d
772	652	618	412	405	110	69	11

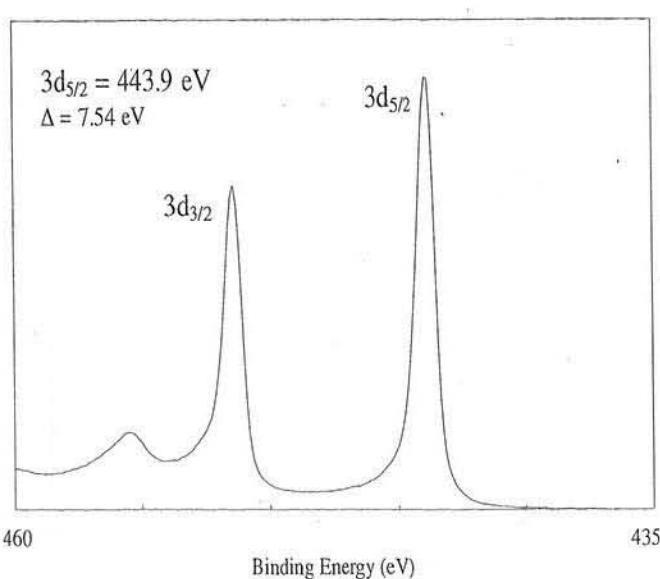
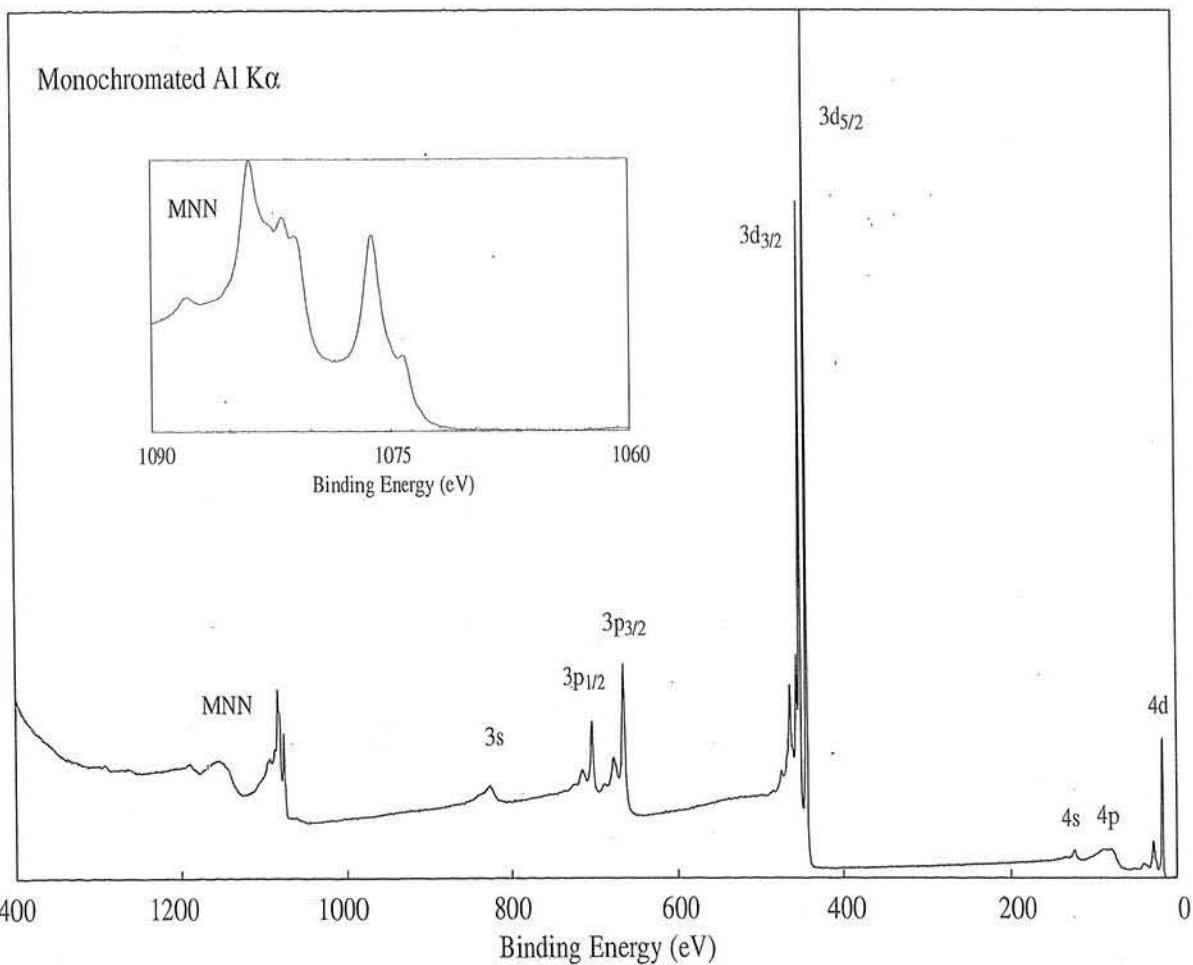
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Auger Lines

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$M_5N_{45}N_{45}$	$M_4N_{45}N_{45}$
1110	1103 (Al)
877	870 (Mg)





Line Positions (eV)

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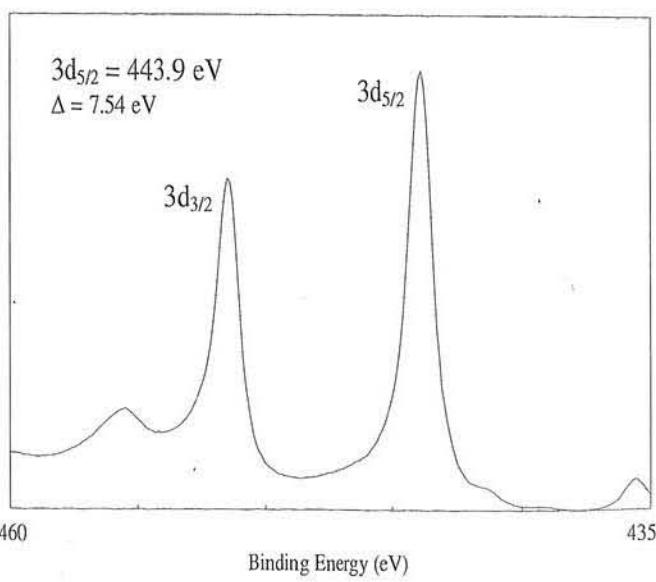
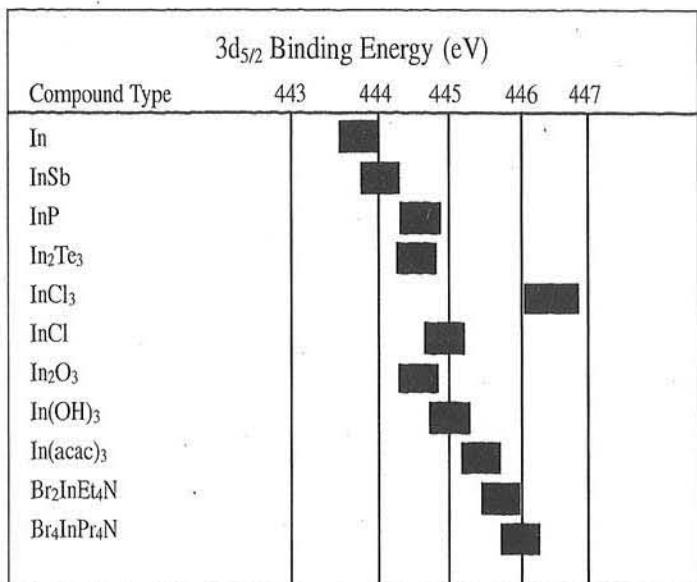
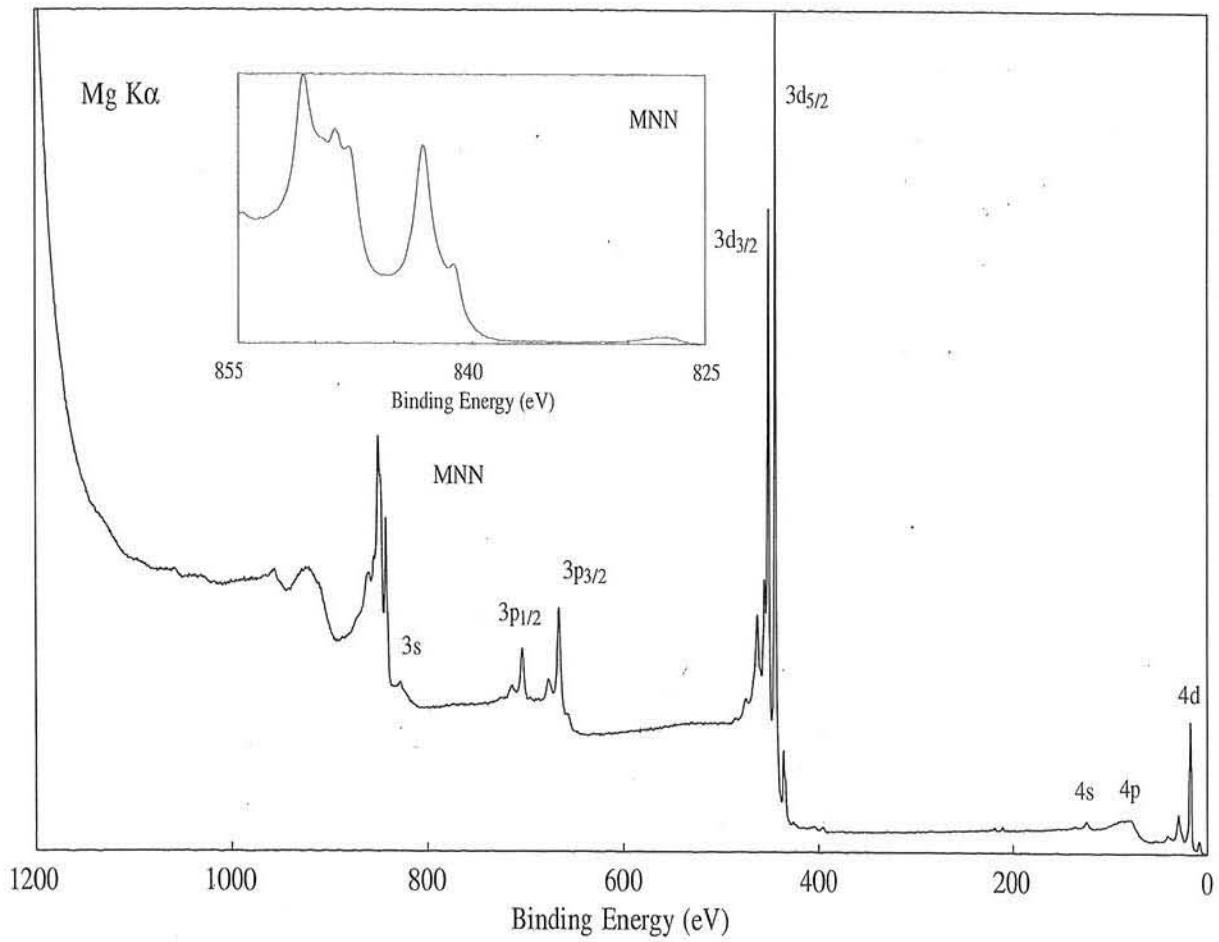
Photoelectron Lines

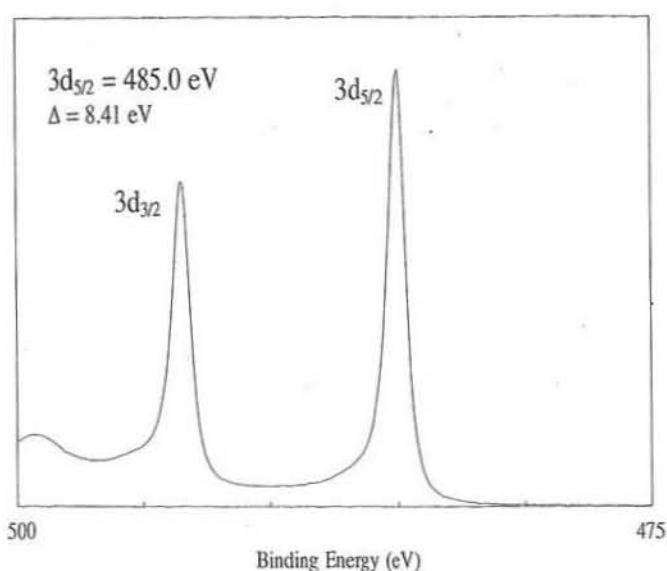
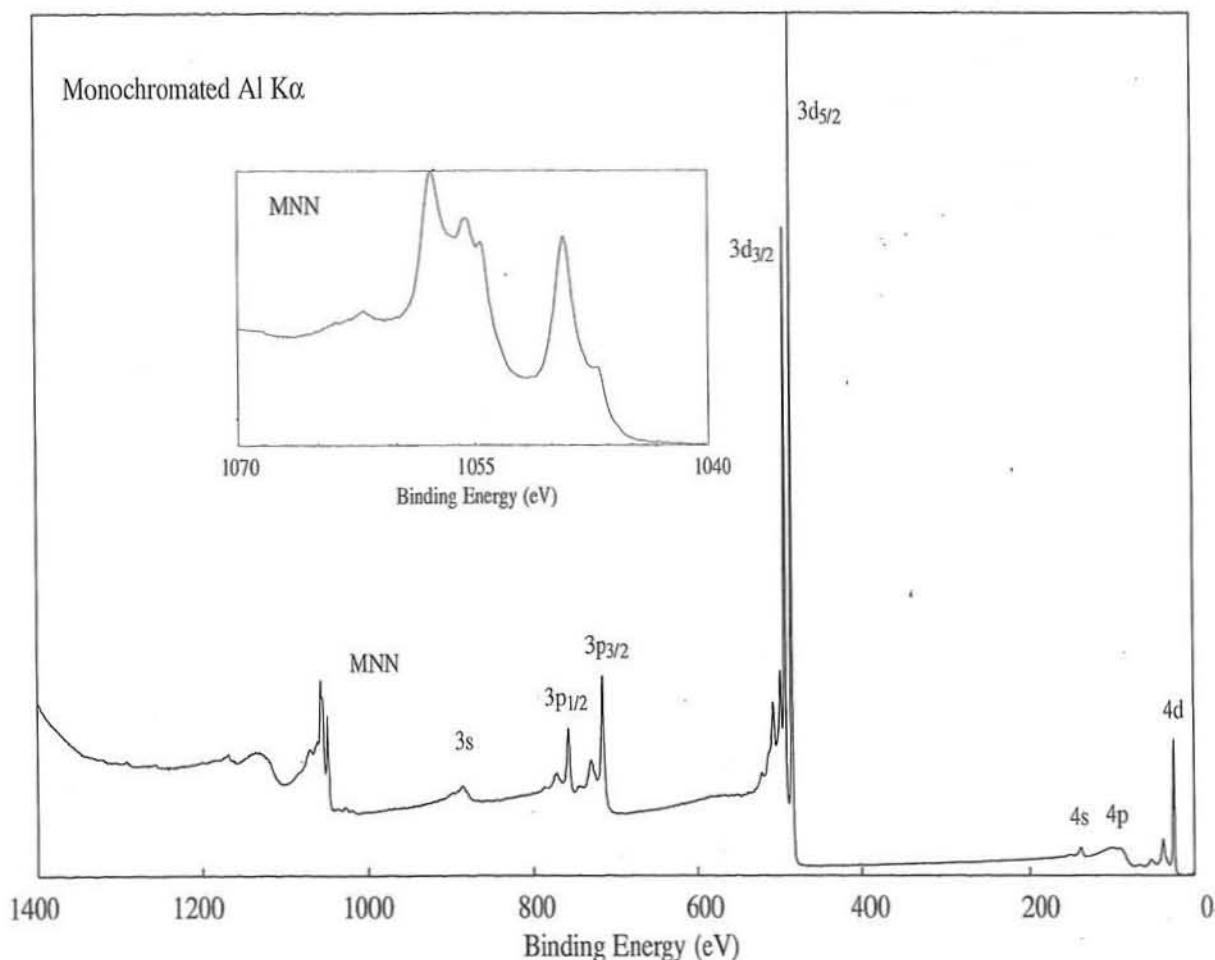
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p	4d
828	703	665	452	444	123	78	17

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Auger Lines

$M_5N_{45}N_{45}$	$M_4N_{45}N_{45}$
1084	1076 (Al)
851	843 (Mg)





Line Positions (eV)

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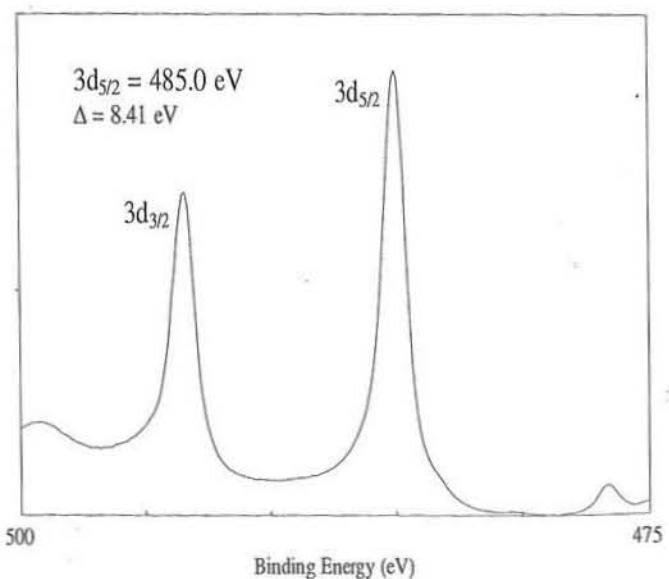
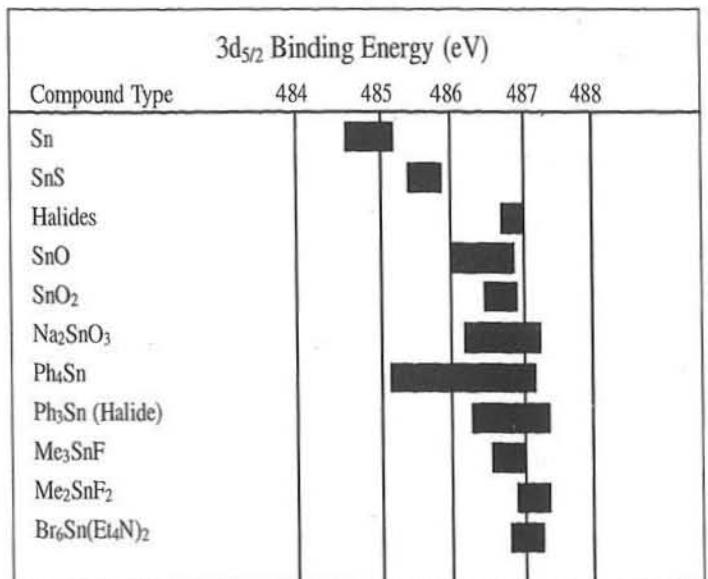
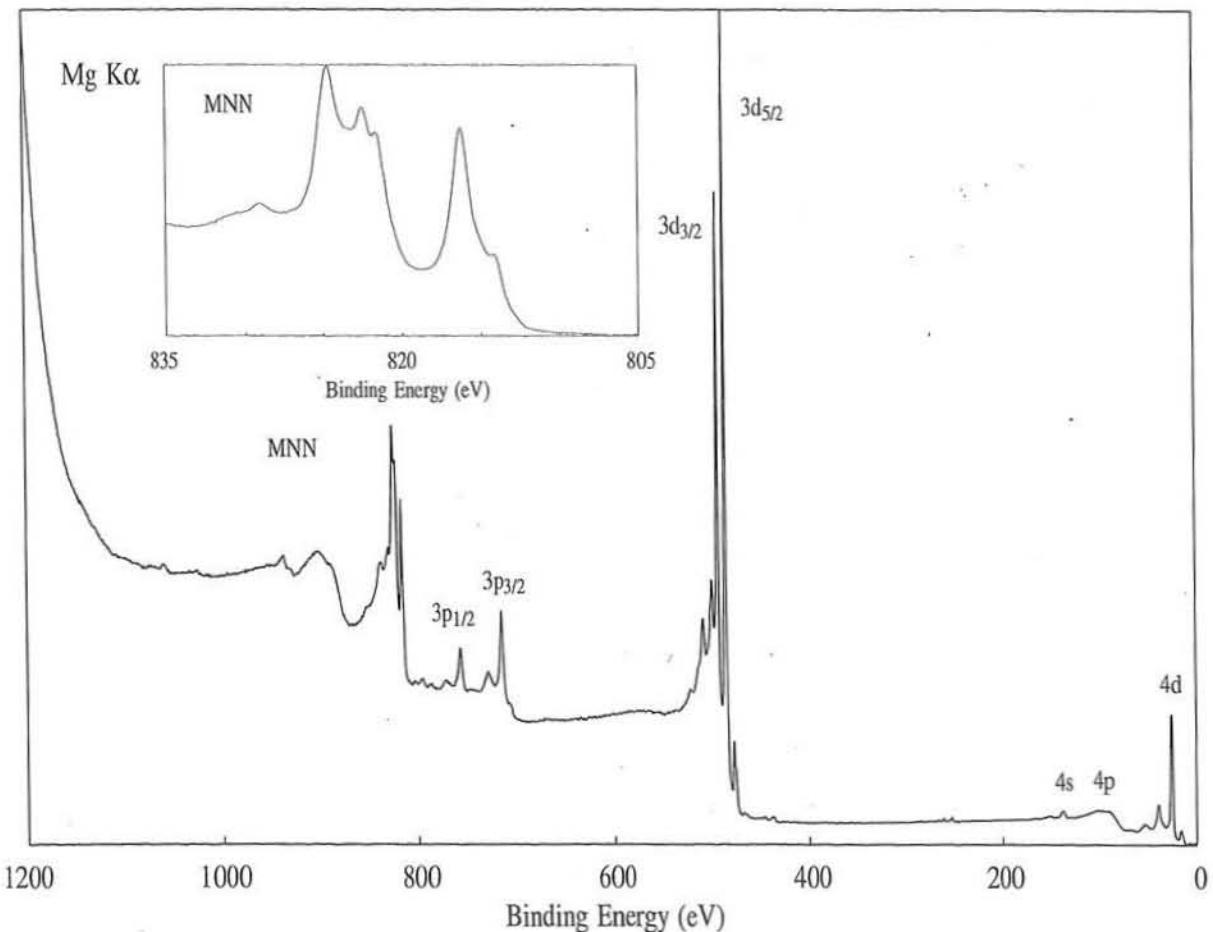
Photoelectron Lines

3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p	4d
885	757	715	493	485	137	89	25

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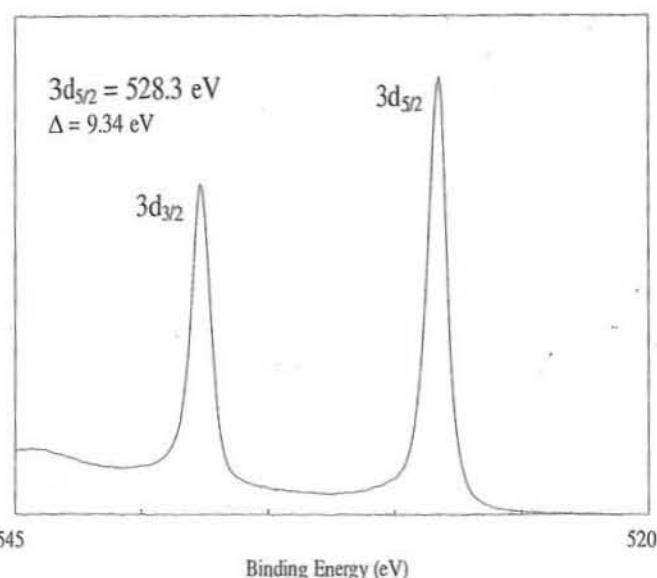
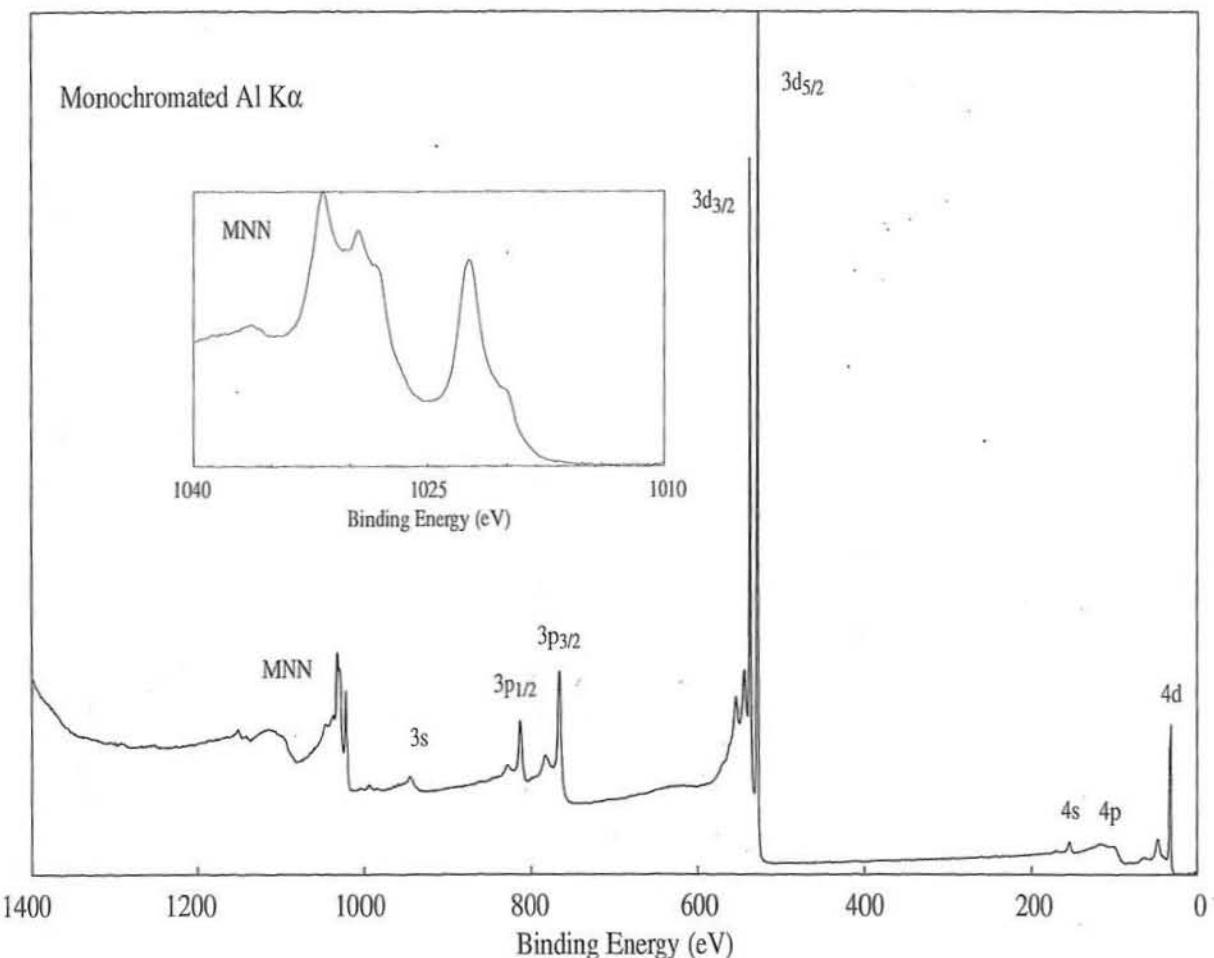
Auger Lines

$M_5N_{45}N_{45}$	$M_4N_{45}N_{45}$
1058	1049 (Al)
825	816 (Mg)



**Antimony Sb**  
Atomic Number 51

Handbook of X-ray Photoelectron Spectroscopy



Line Positions (eV)

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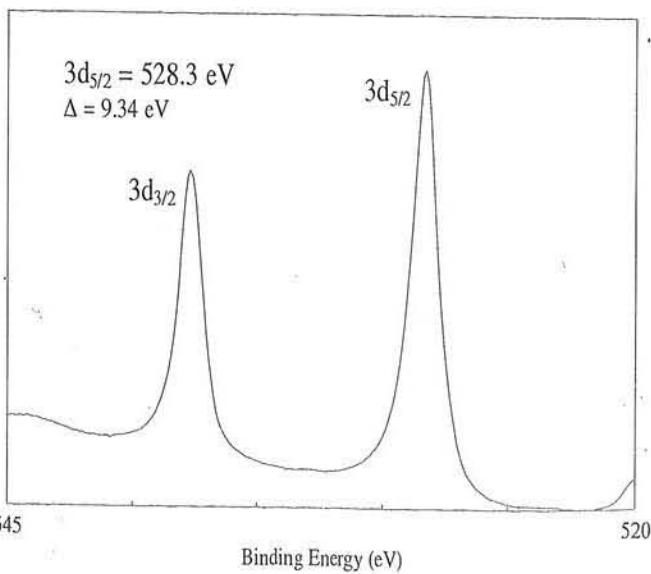
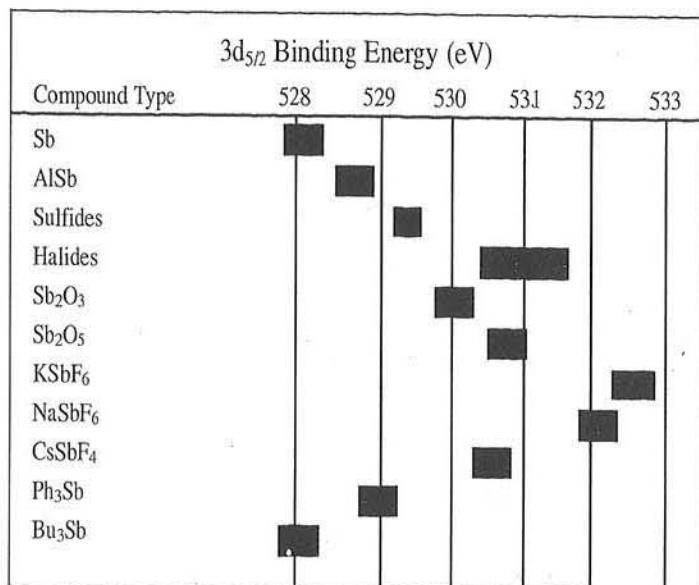
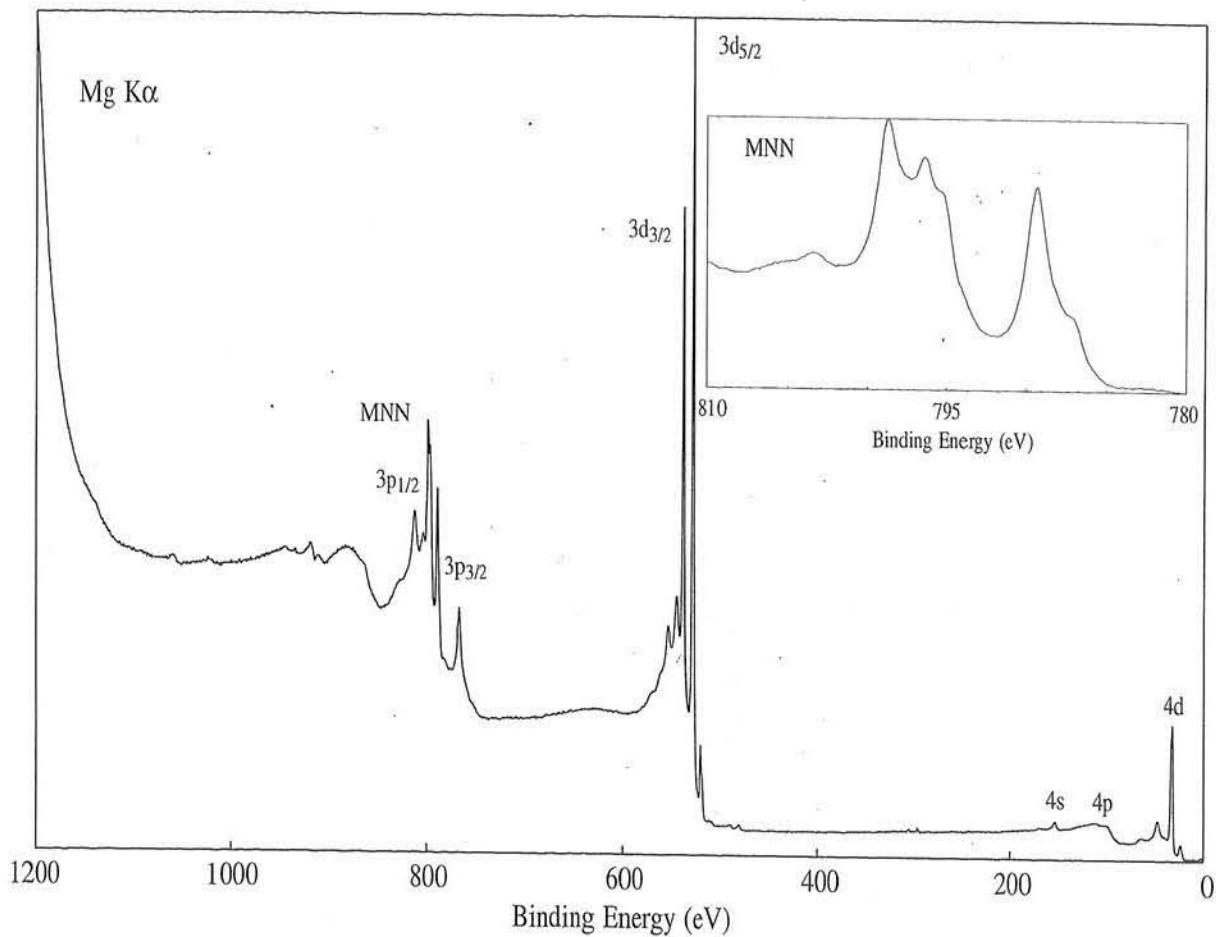
Photoelectron Lines

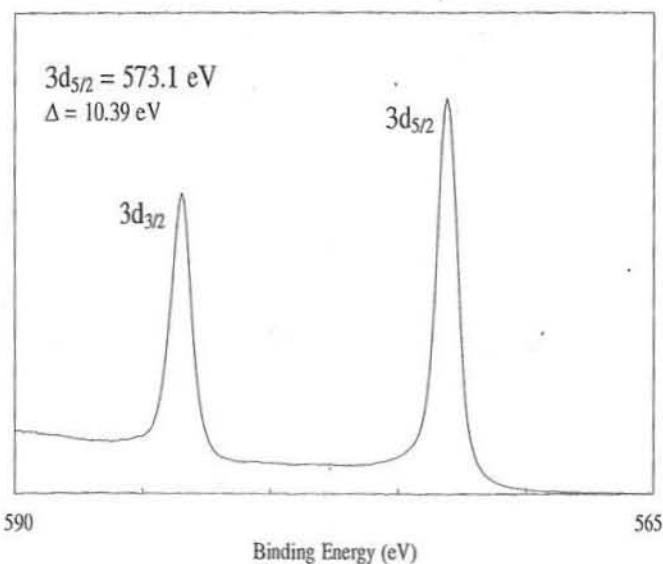
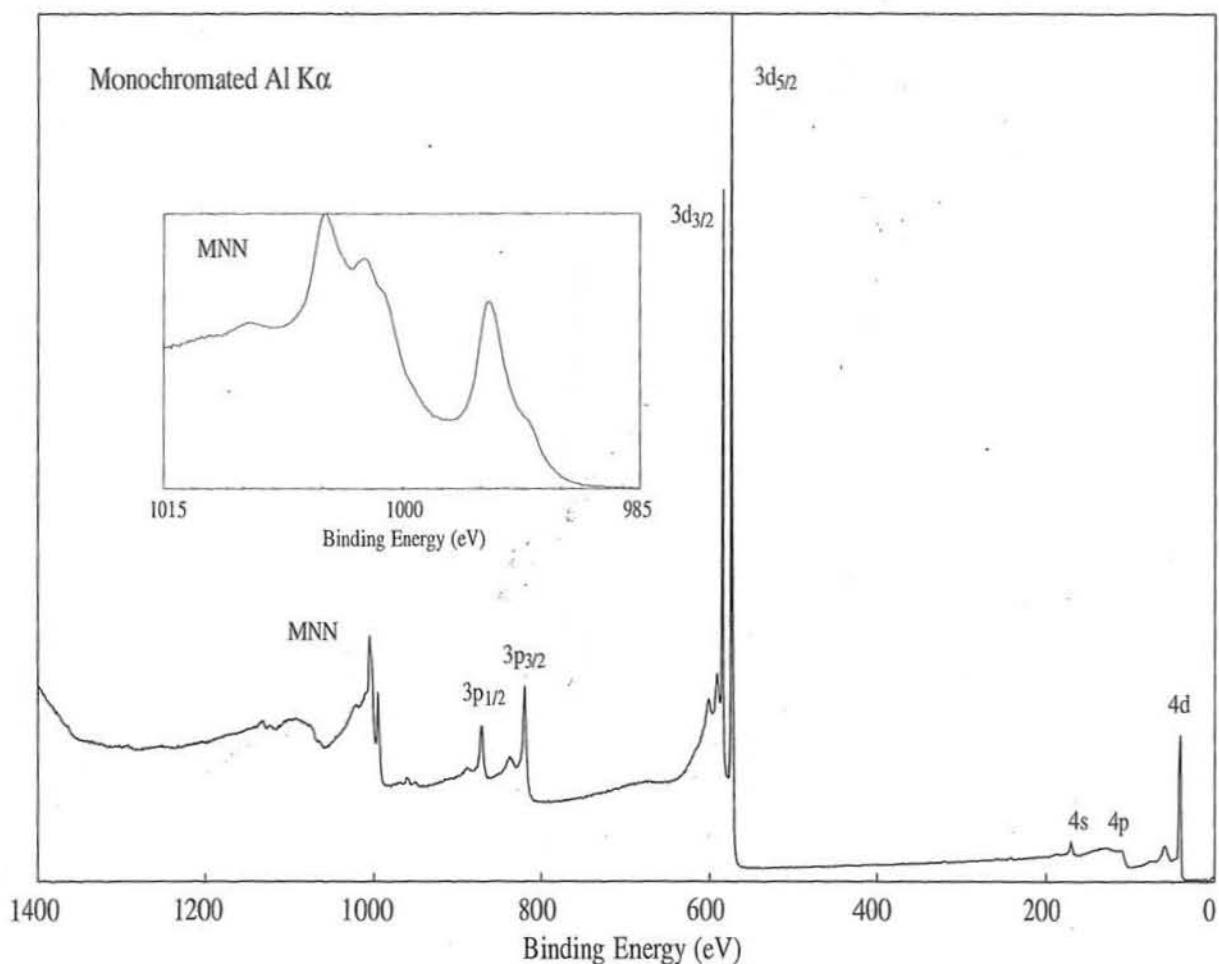
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p	4d
944	813	767	537	528	153	99	33

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Auger Lines

M <sub>5</sub> N <sub>45</sub> N <sub>45</sub>	M <sub>4</sub> N <sub>45</sub> N <sub>45</sub>
1032	1022 (Al)
799	789 (Mg)





Line Positions (eV)

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Photoelectron Lines

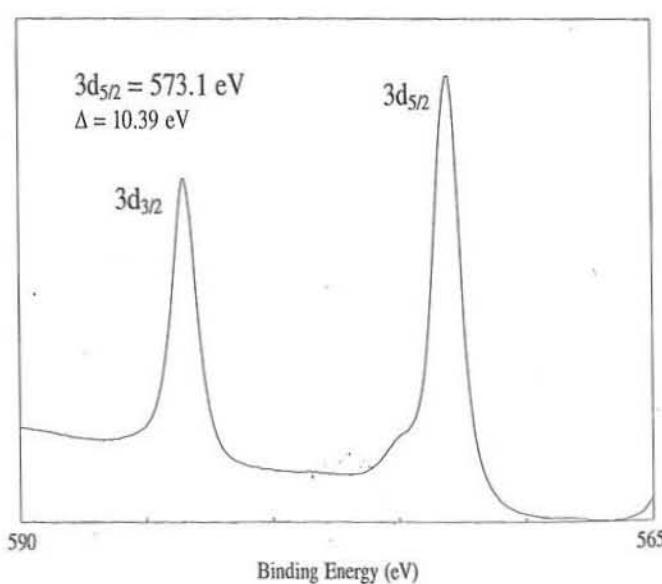
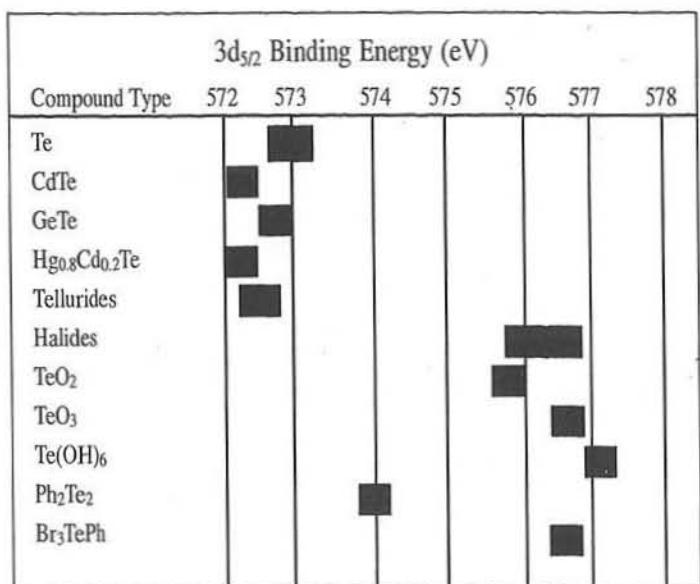
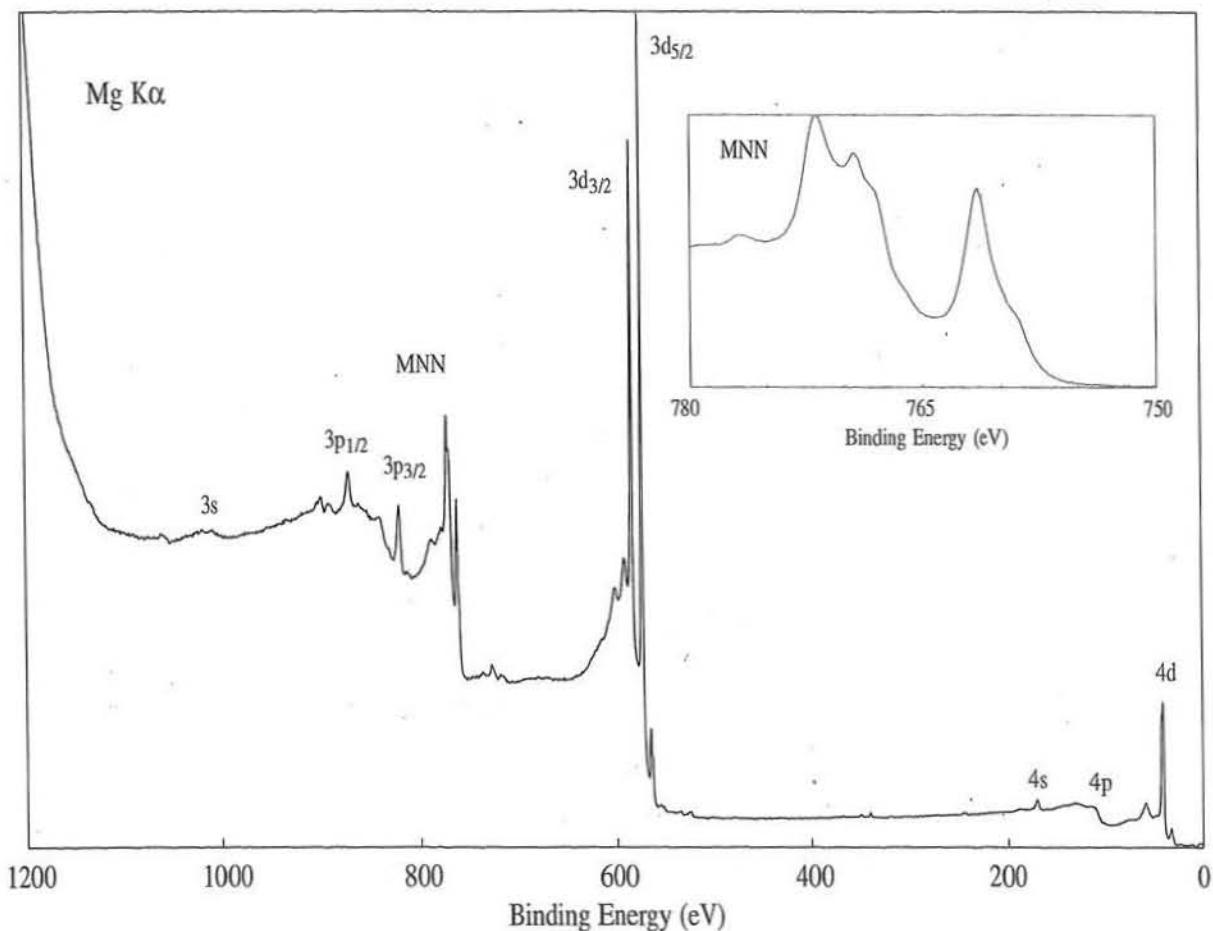
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>
1009	871	820	583	573
4s	4p	4d <sub>3/2</sub>	4d <sub>5/2</sub>	5s
170	111	42	41	12

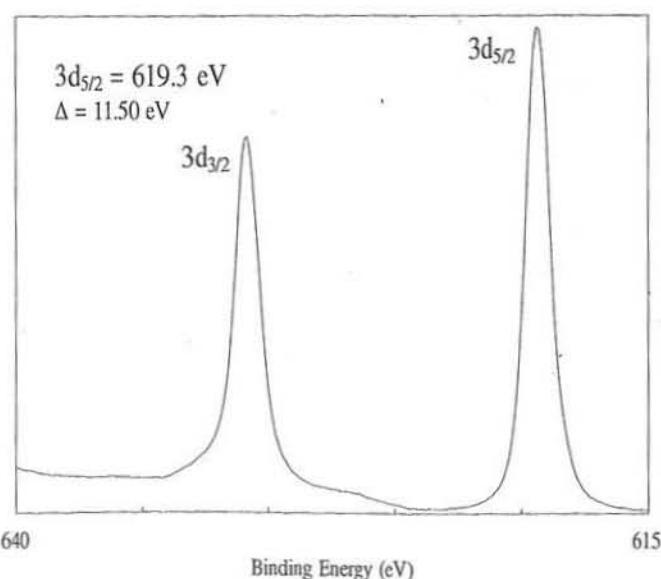
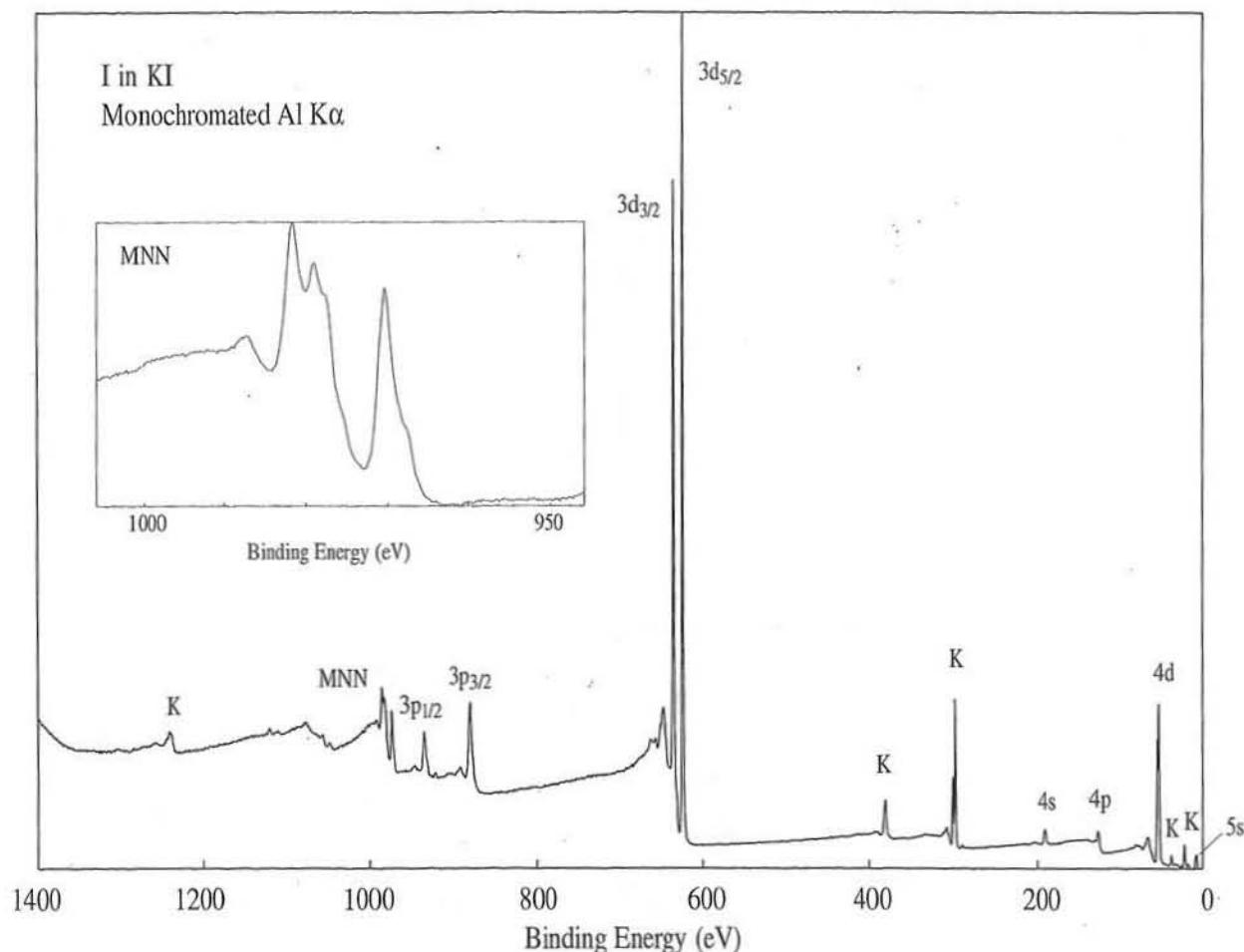
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Auger Lines

$M_5N_{45}N_{45}$	$M_4N_{45}N_{45}$
1005	995 (Al)
772	762 (Mg)







Line Positions (eV)

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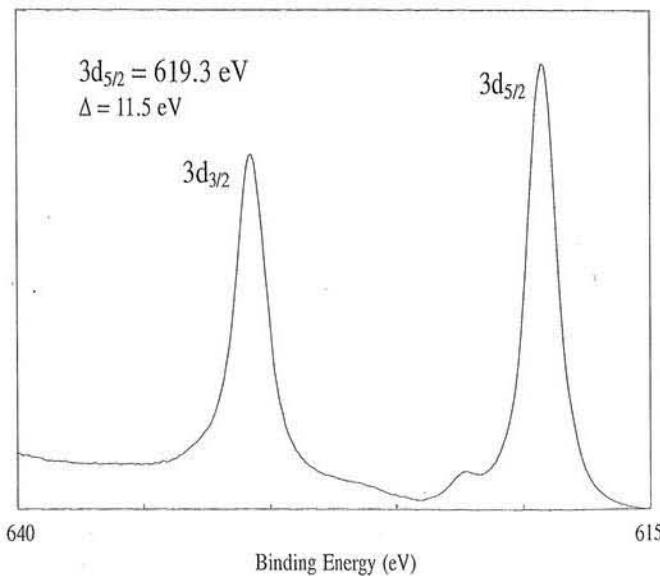
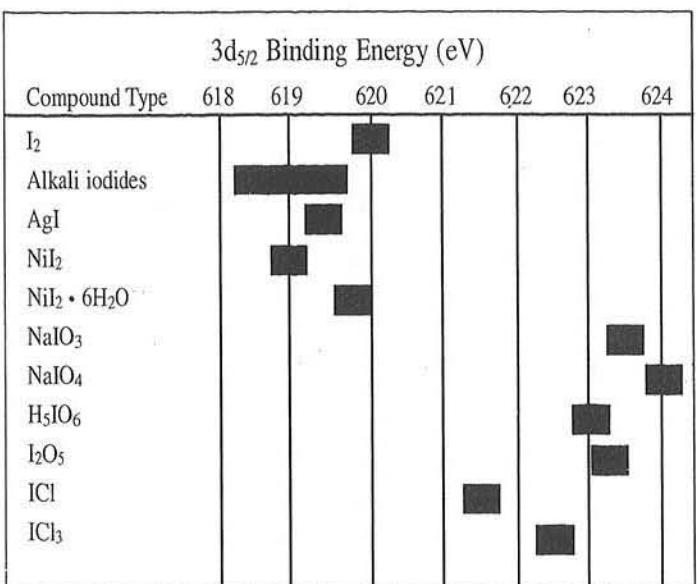
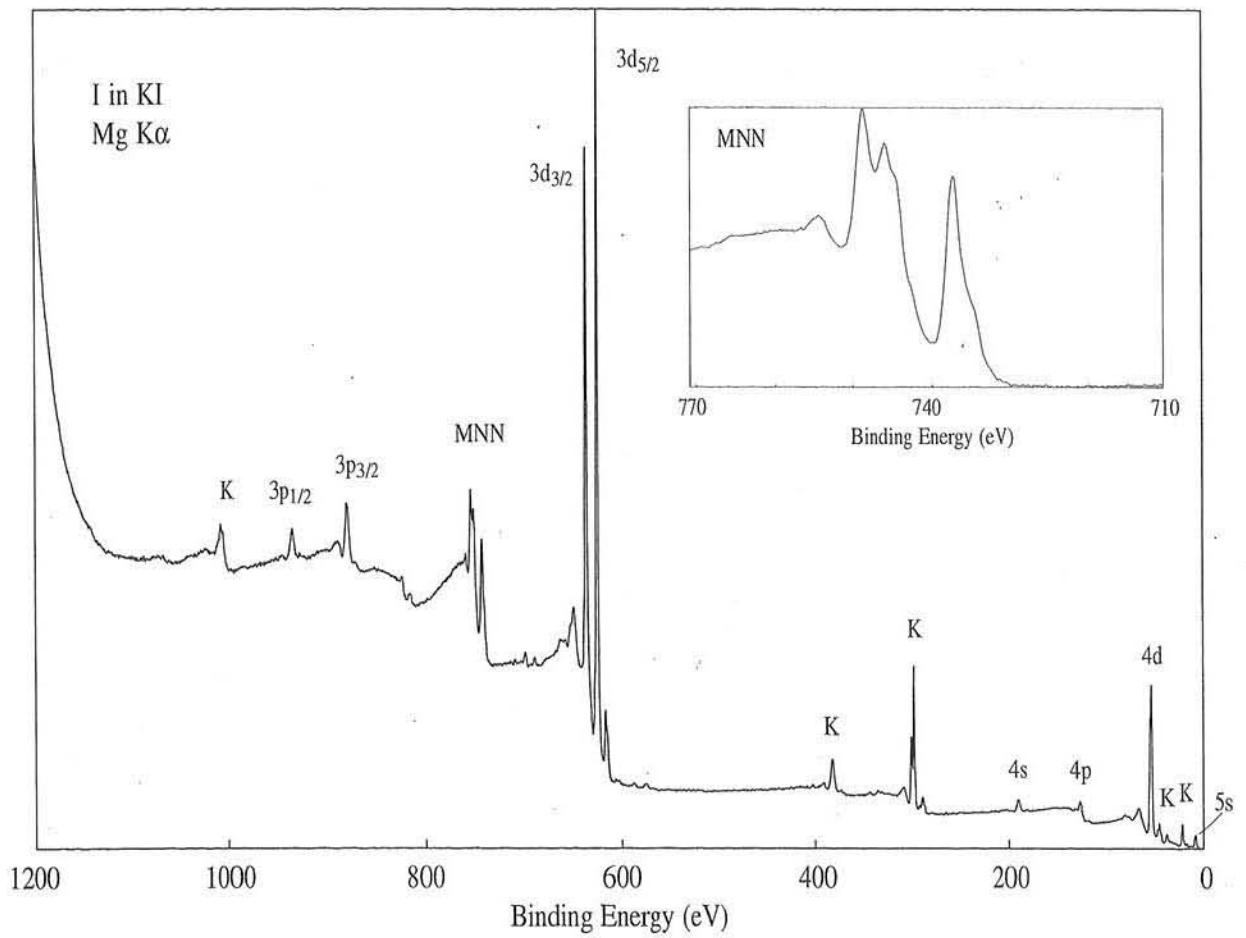
Photoelectron Lines

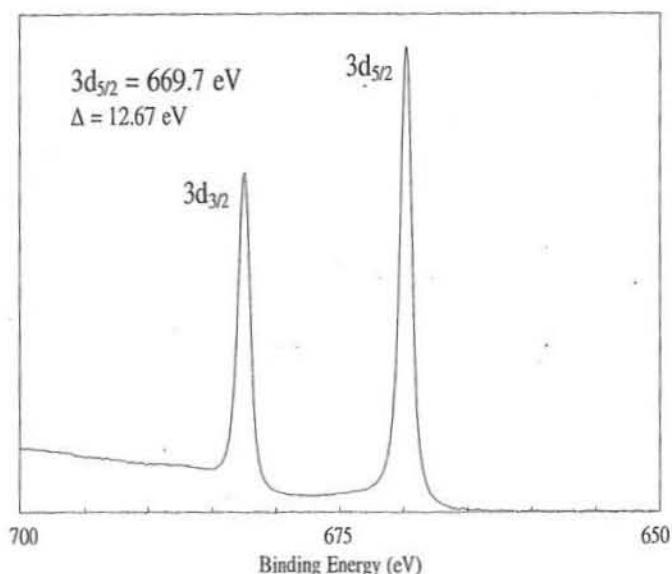
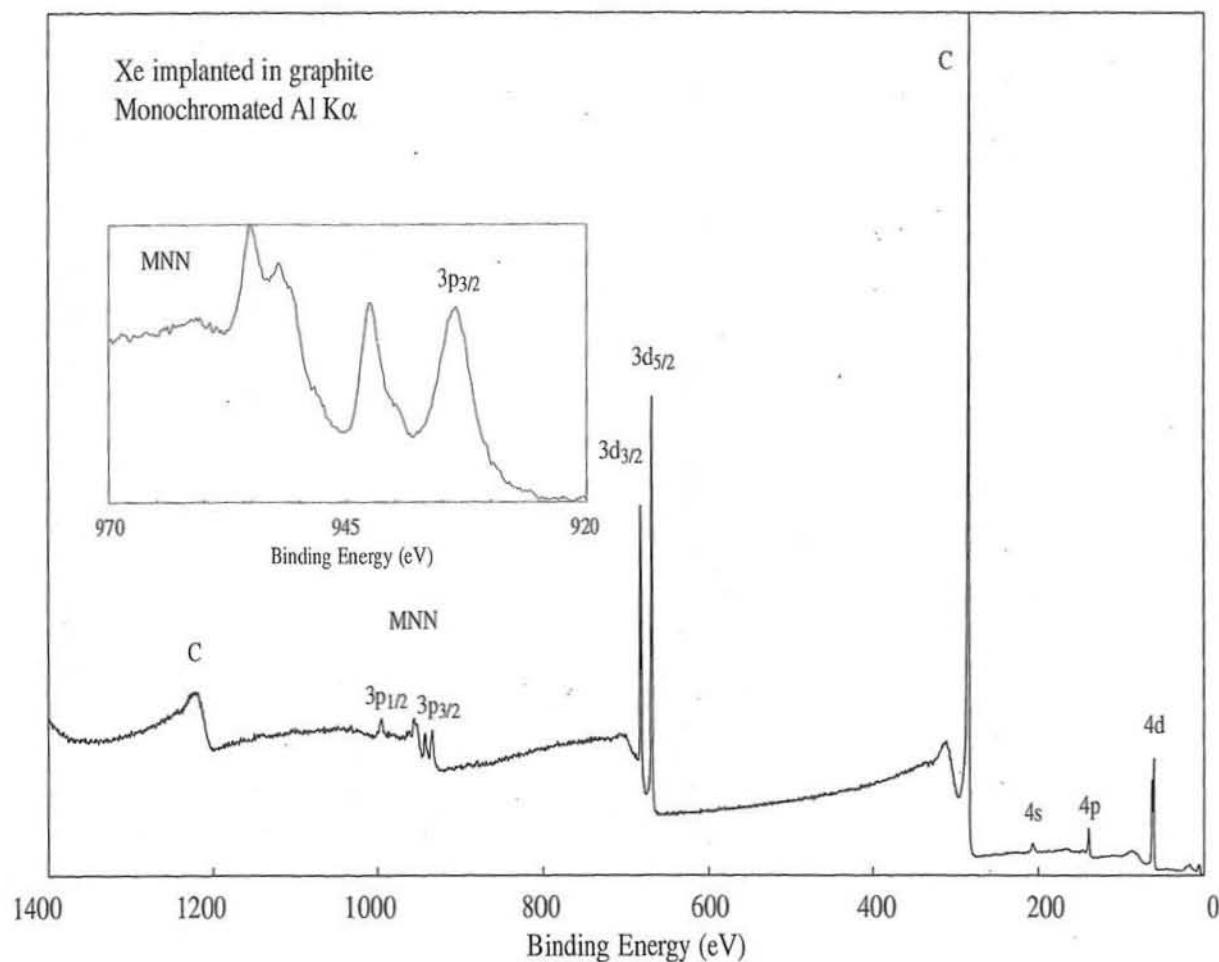
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>
1071	930	875	630	619
4s	4p	4d <sub>3/2</sub>	4d <sub>5/2</sub>	5s
187	123	51	49	18

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Auger Lines

M <sub>5</sub> N <sub>45</sub> N <sub>45</sub>	M <sub>4</sub> N <sub>45</sub> N <sub>45</sub>
982	971 (Al)
749	738 (Mg)





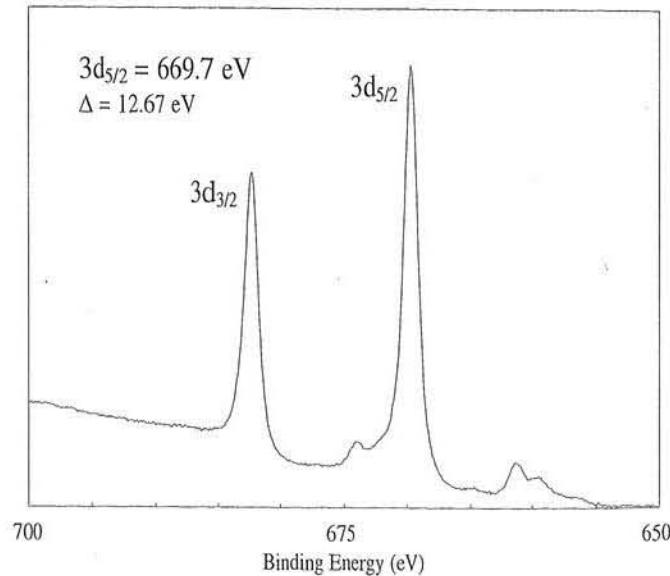
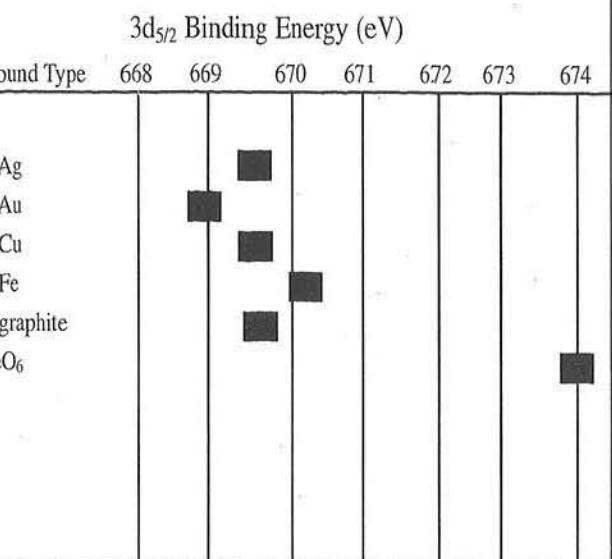
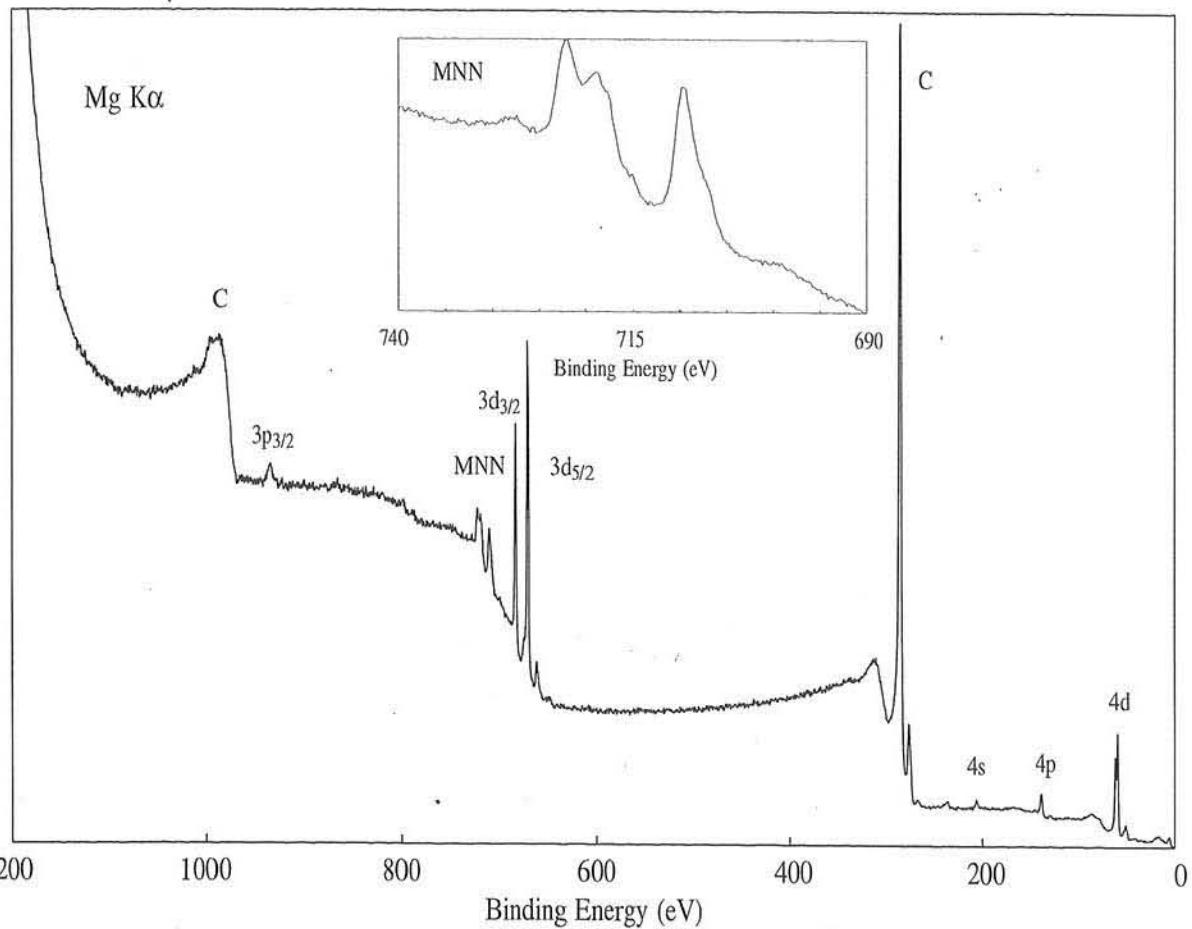
### Line Positions (eV)

## Photoelectron Lines

3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>
1141	996	934	683	670
4s	4p	4d <sub>3/2</sub>	4d <sub>5/2</sub>	5s
207	139	63	61	17

## Auger Lines

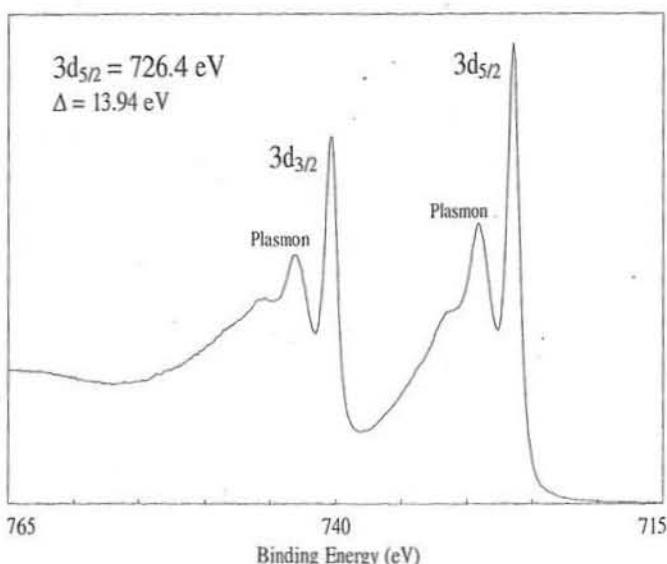
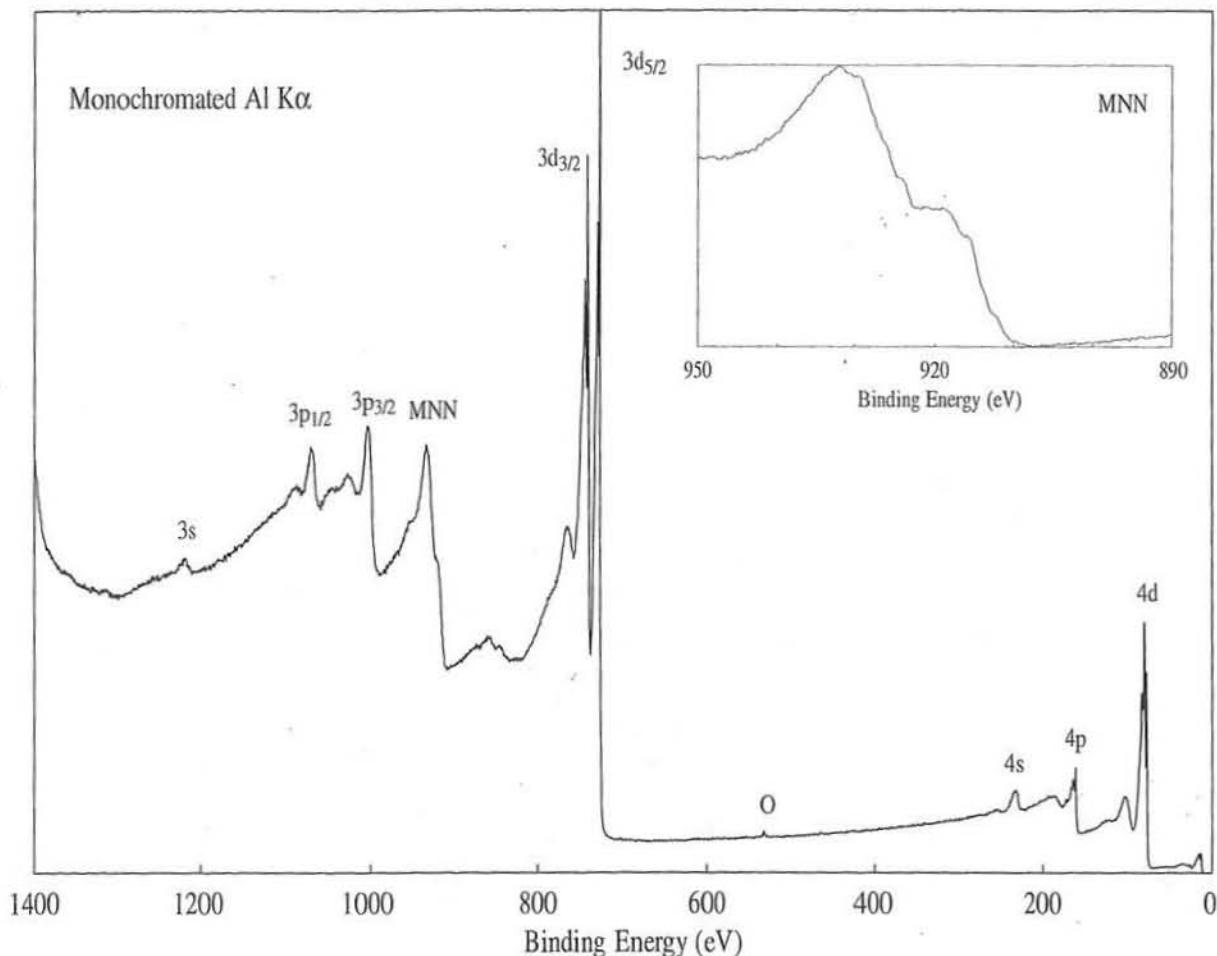
$M_5N_{45}N_{45}$	$M_4N_{45}N_{45}$
955	942 (Al)
722	709 (Mg)



# Cesium Cs

Atomic Number 55

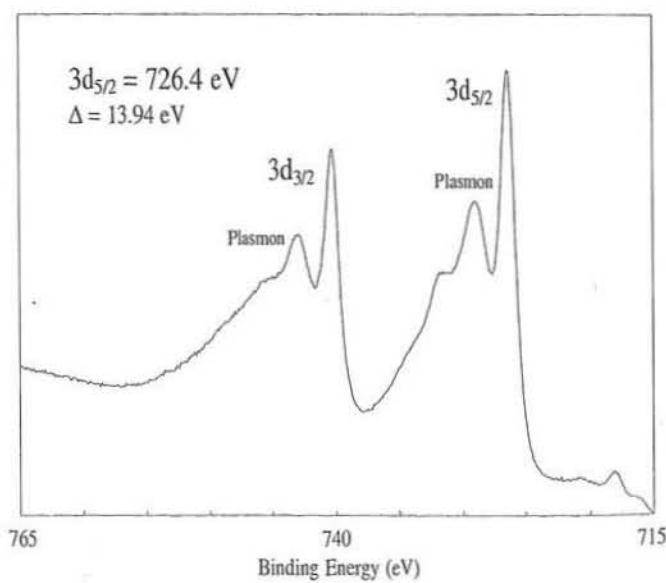
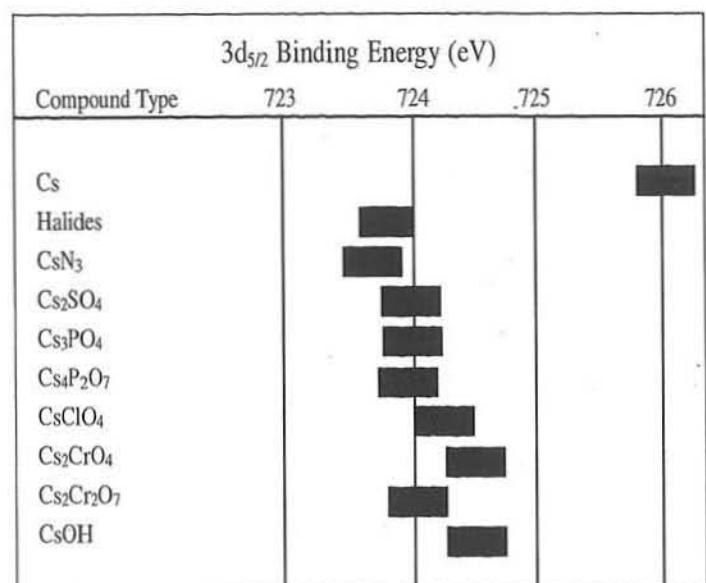
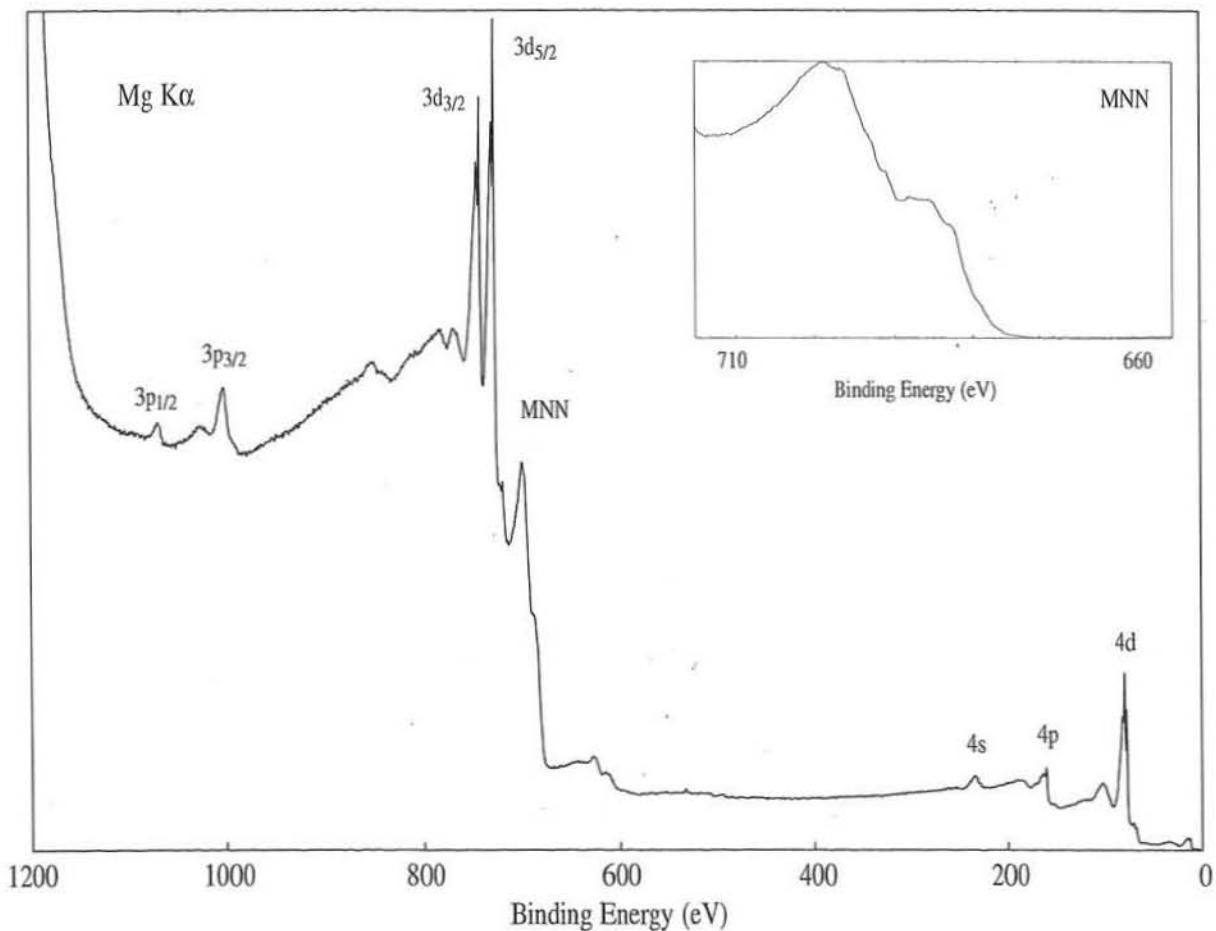
## Handbook of X-ray Photoelectron Spectroscopy

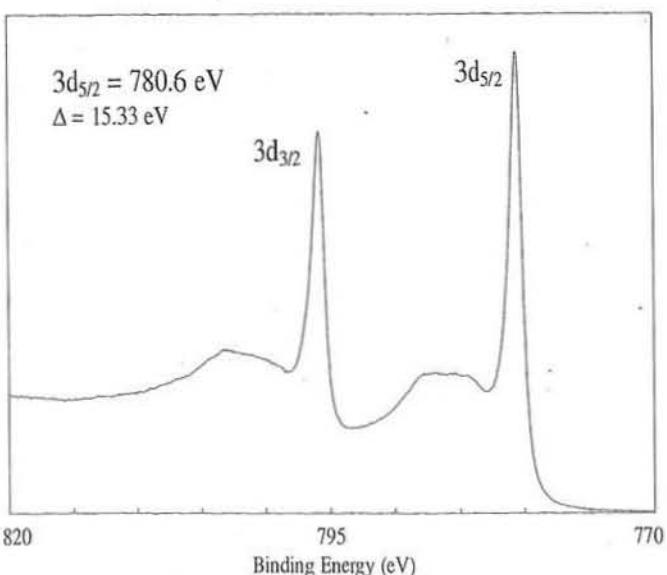
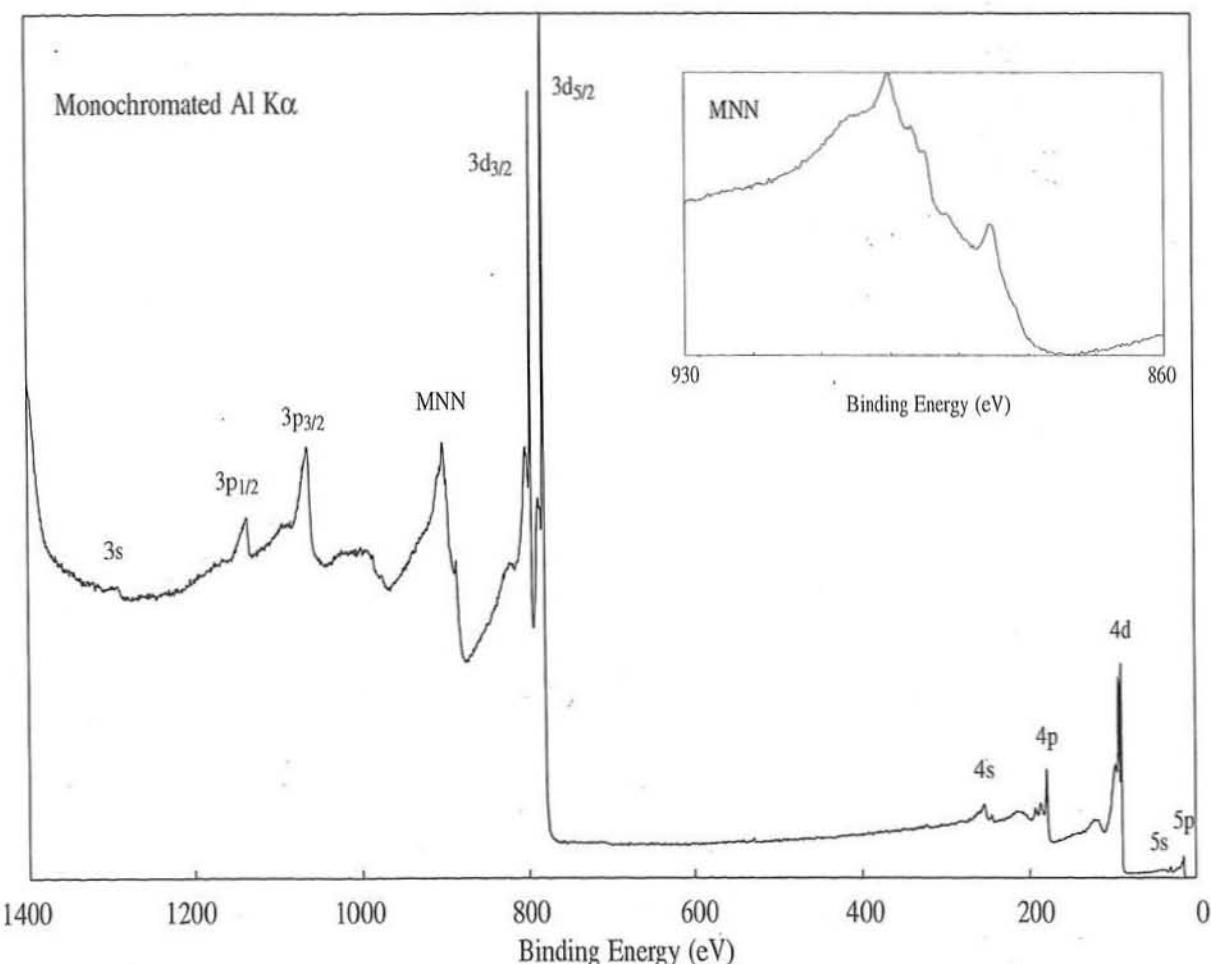


Line Positions (eV)				
<u>Photoelectron Lines</u>				
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>
1219	1069	1002	740	726
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>
234	173	161	80	77
				5s
				25
<u>Auger Lines</u>				
$M_5N_{45}N_{45}$		$M_4N_{45}N_{45}$		
931		918	(Al)	
698		685	(Mg)	



Perkin-Elmer Corporation  
Physical Electronics Division





Line Positions (eV)

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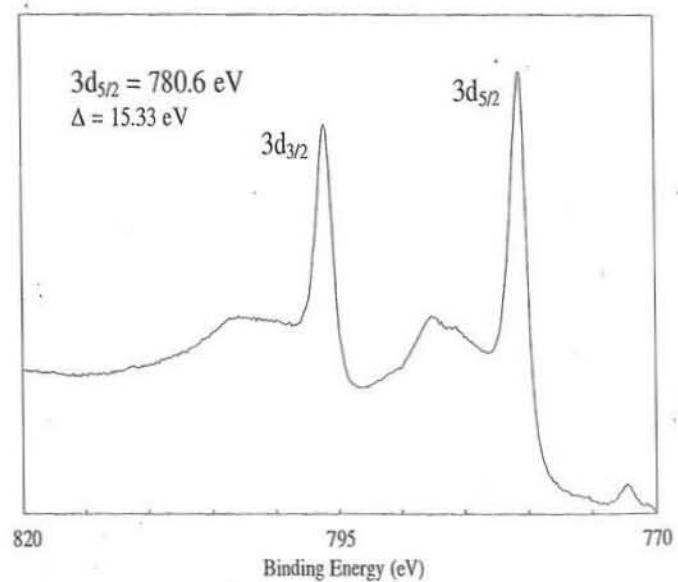
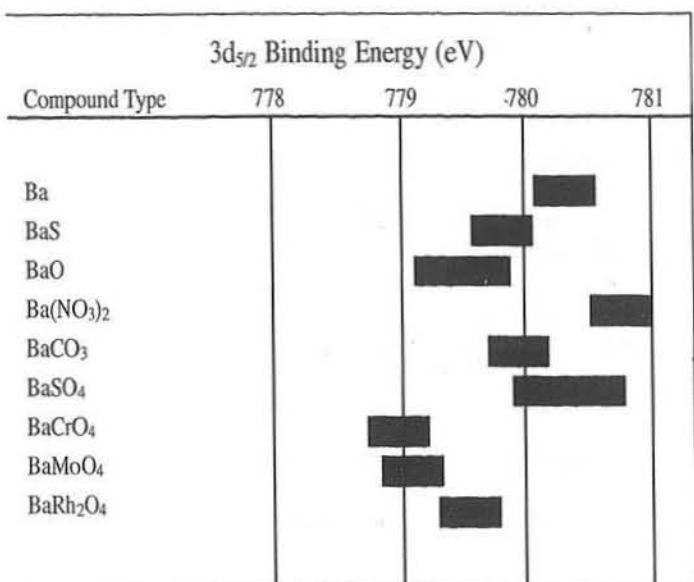
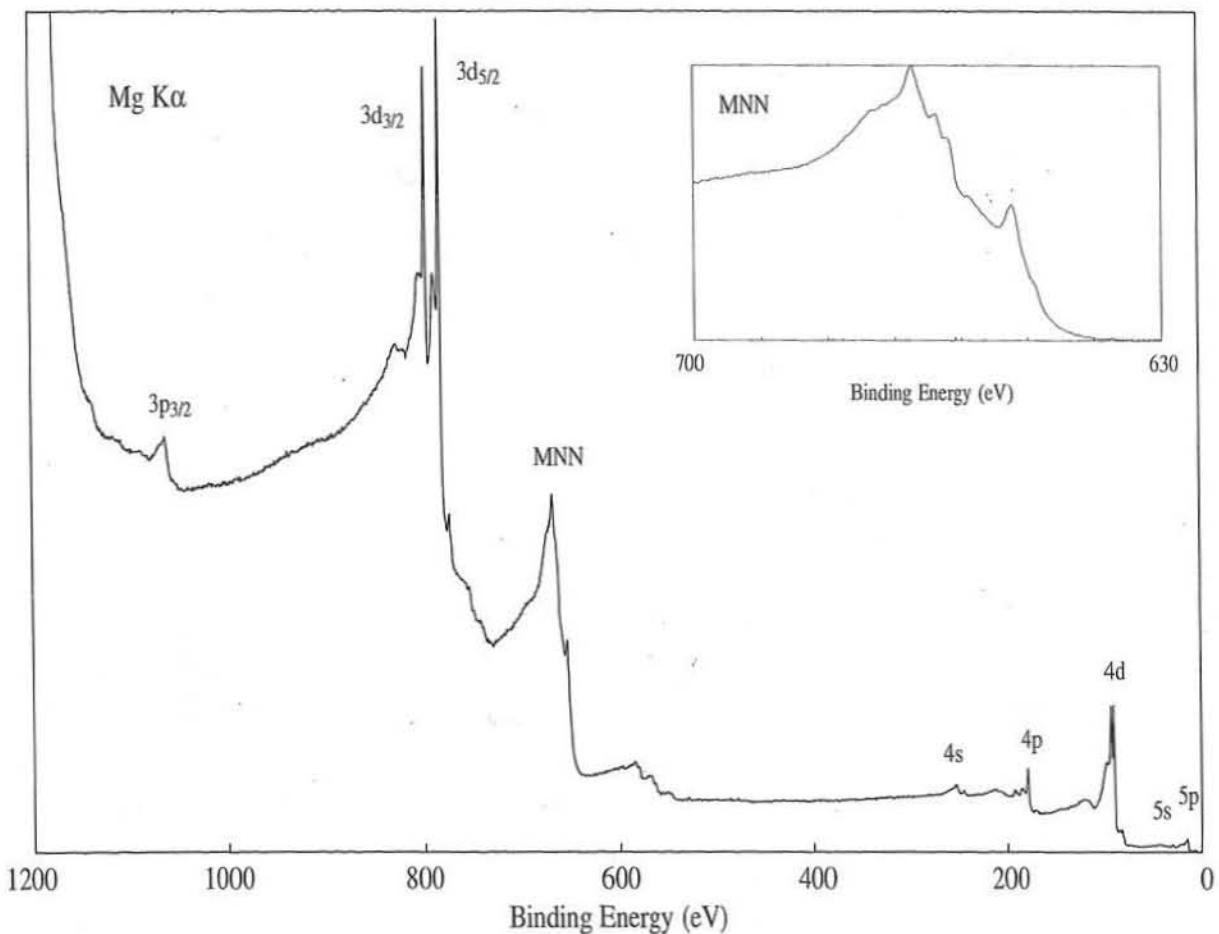
Photoelectron Lines

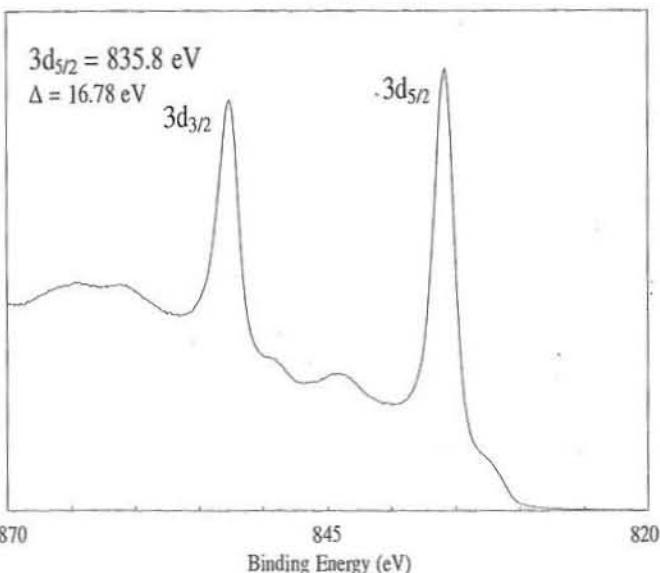
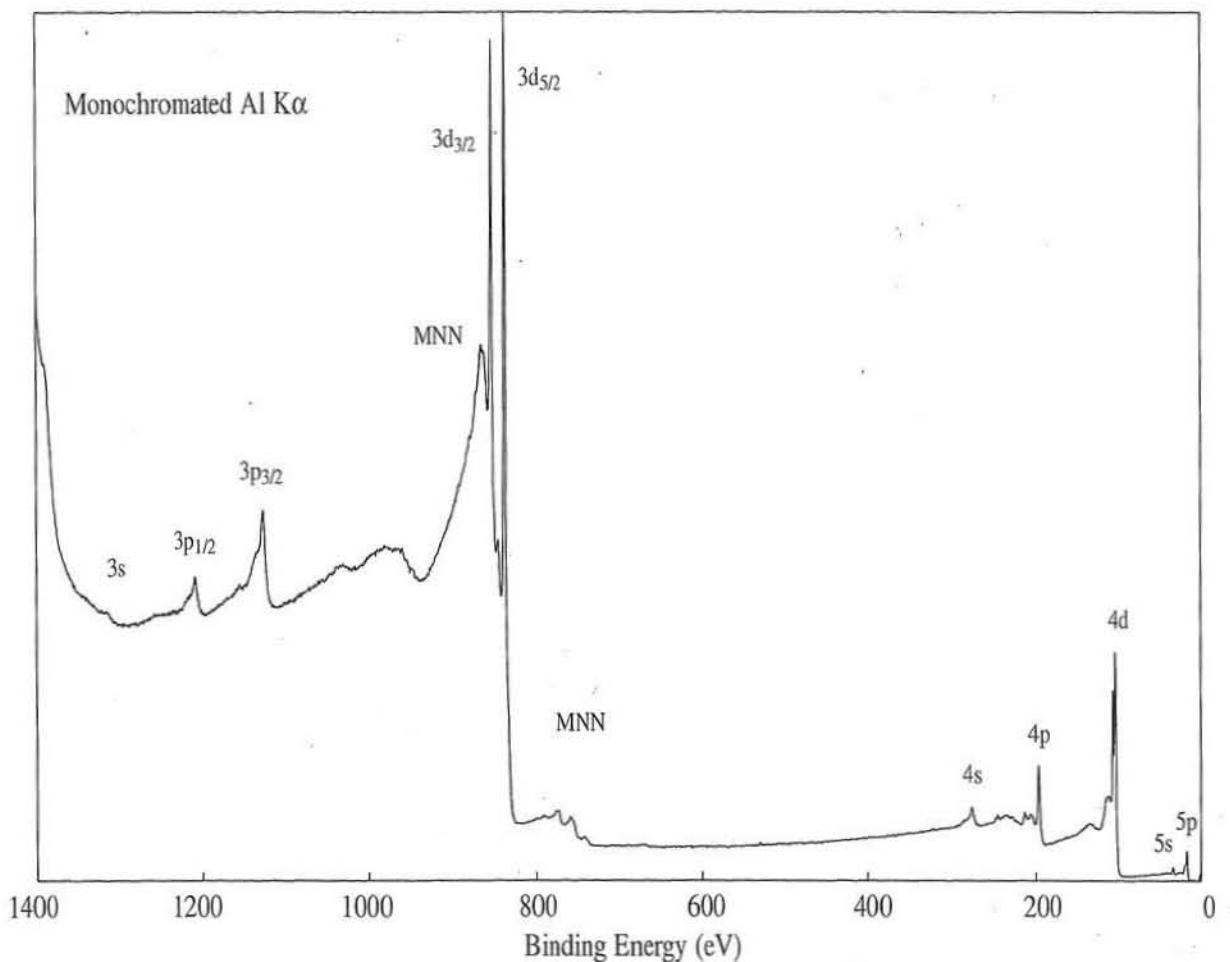
3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>
1292	1138	1064	796	781

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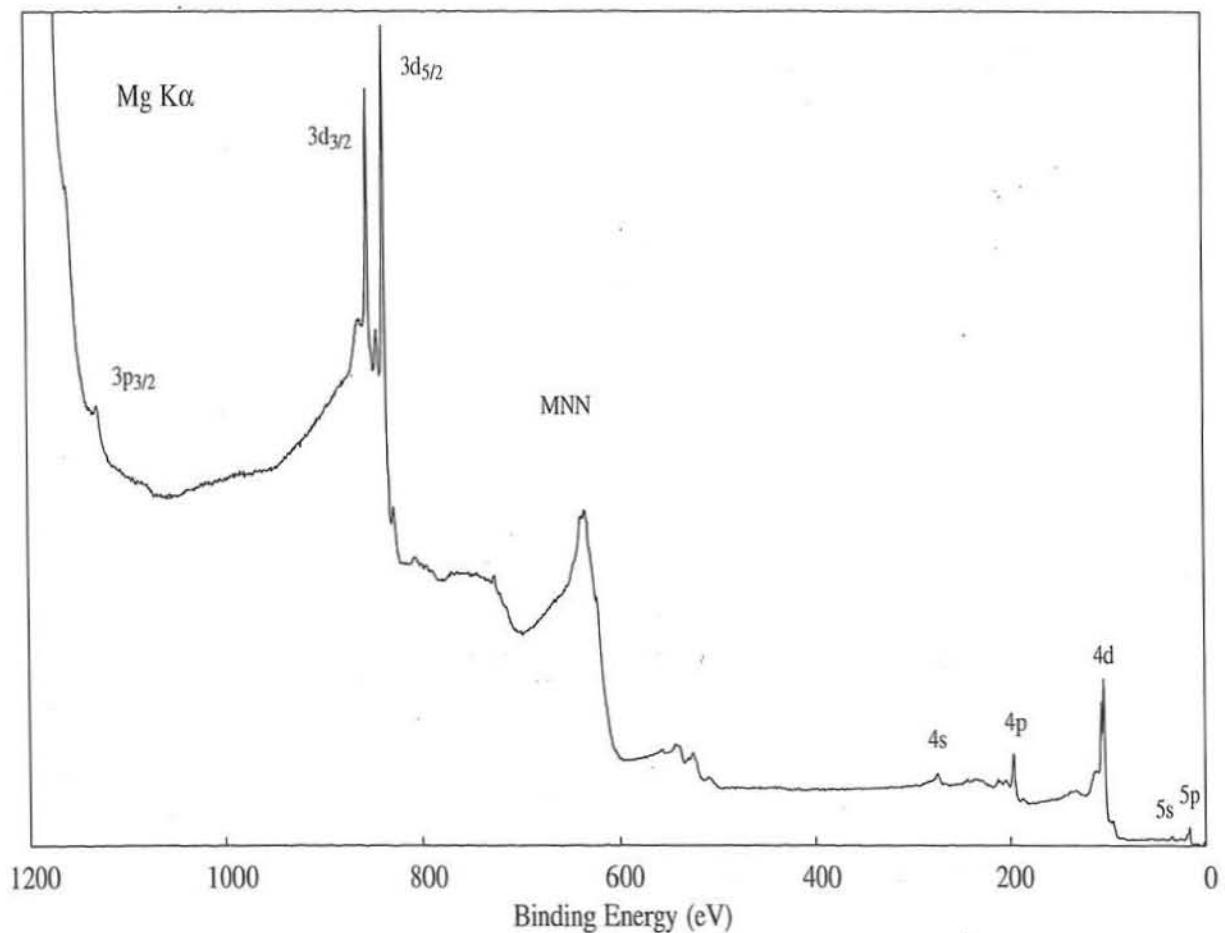
Auger Lines

M <sub>5</sub> N <sub>45</sub> N <sub>45</sub>	M <sub>4</sub> N <sub>45</sub> N <sub>45</sub>
900	886 (Al)
667	653 (Mg)

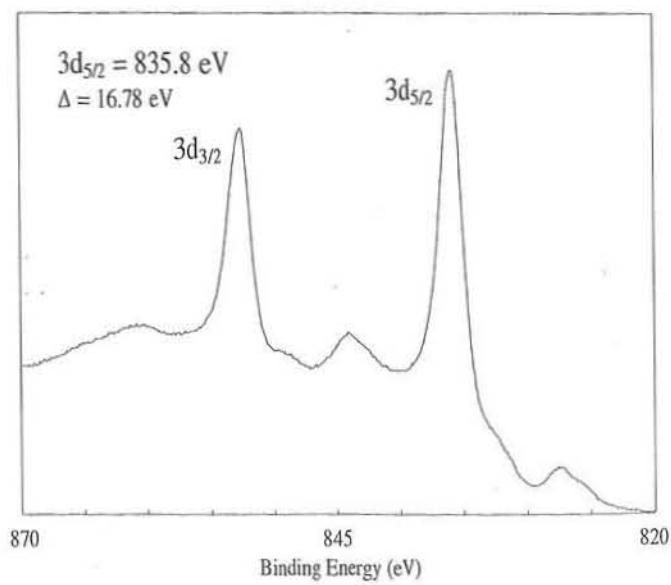


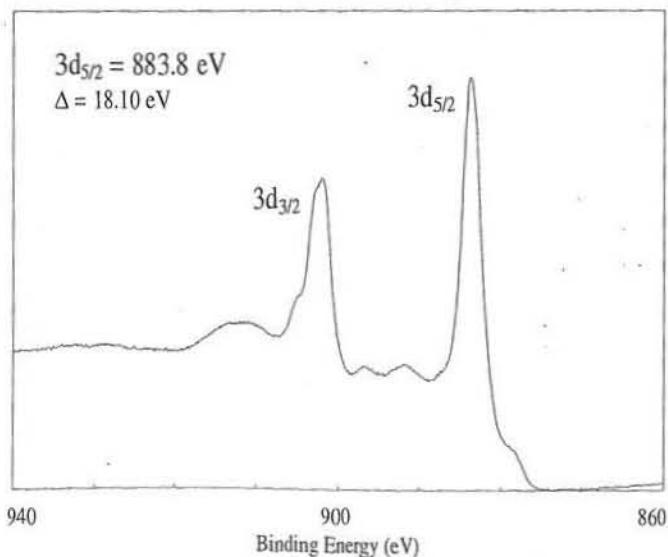
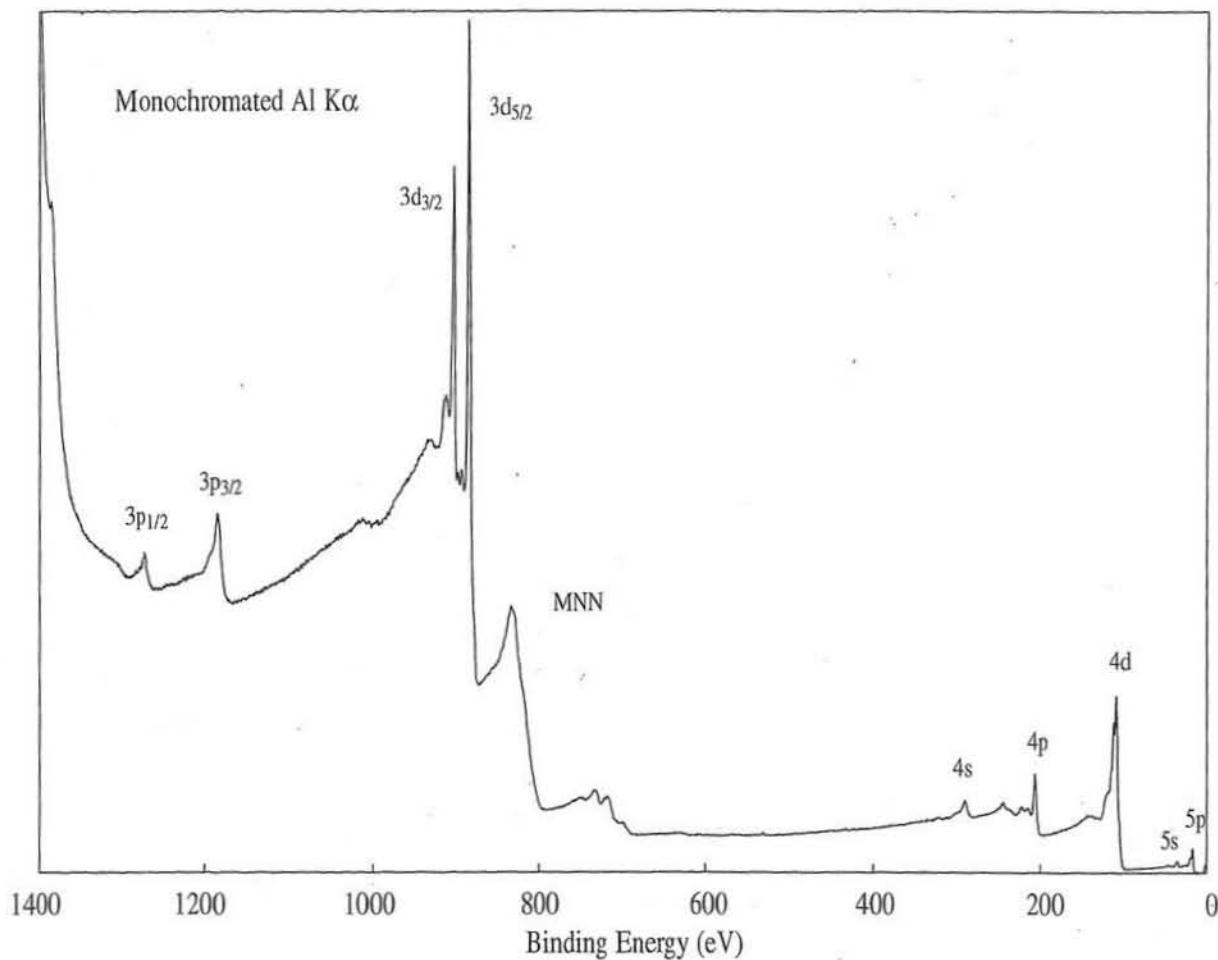


Line Positions (eV)						
Photoelectron Lines						
3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>			
1208	1128	853	836			
Auger Lines						
$M_5N_45N_{45}$		$M_4N_45N_{45}$				
867		854	(Al)			
634		621	(Mg)			



Compound Type	3d <sub>5/2</sub> Binding Energy (eV)						
	833	834	835	836	837	838	839
La							
LaH <sub>2</sub>							
La <sub>2</sub> O <sub>3</sub>							

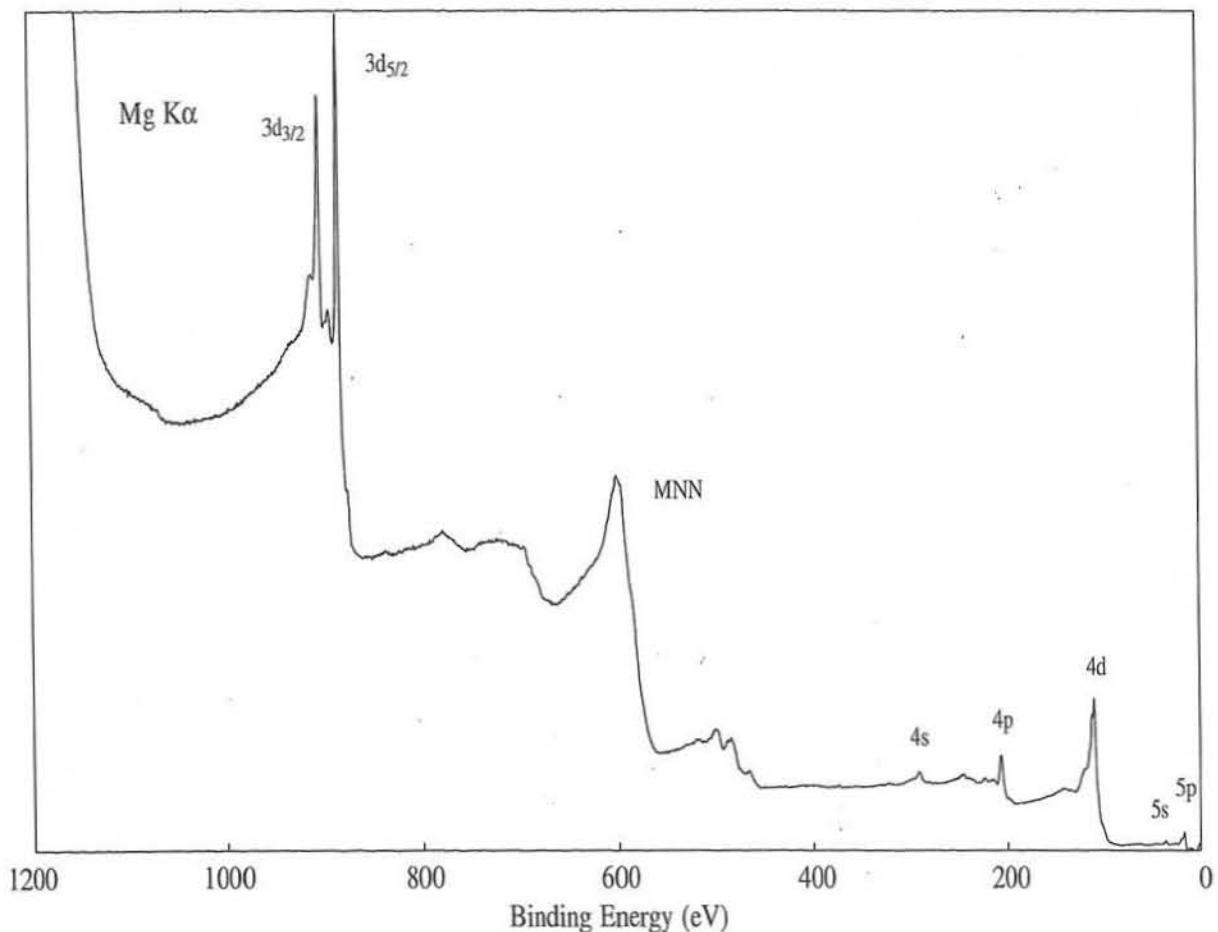




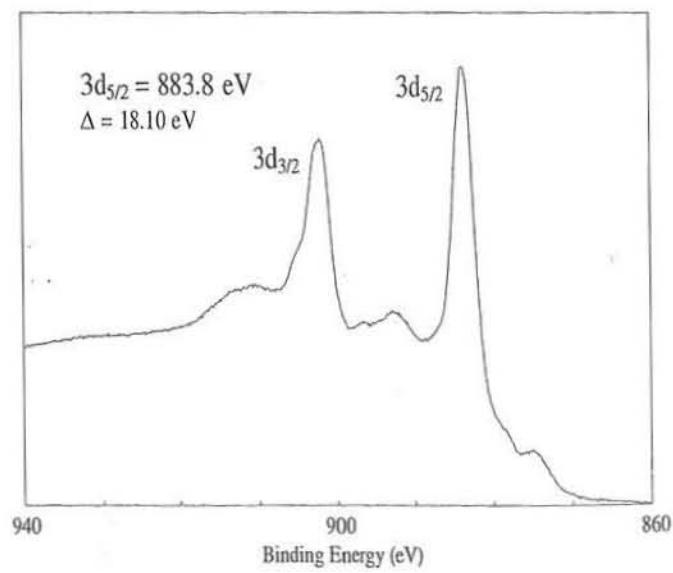
Line Positions (eV)						
Photoelectron Lines						
3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>			
1272	1184	902	884			
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>	5s	5p
290	223	207	112	109	36	18

Auger Lines

M <sub>45</sub> N <sub>45</sub> N <sub>45</sub>	
833	(Al)
600	(Mg)



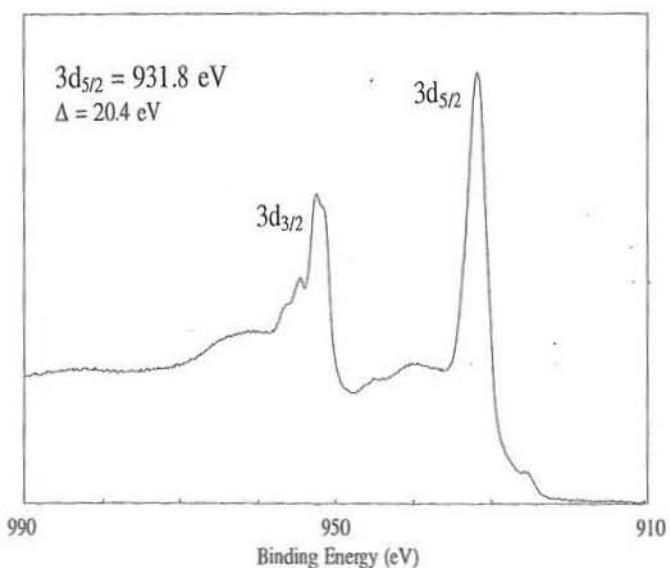
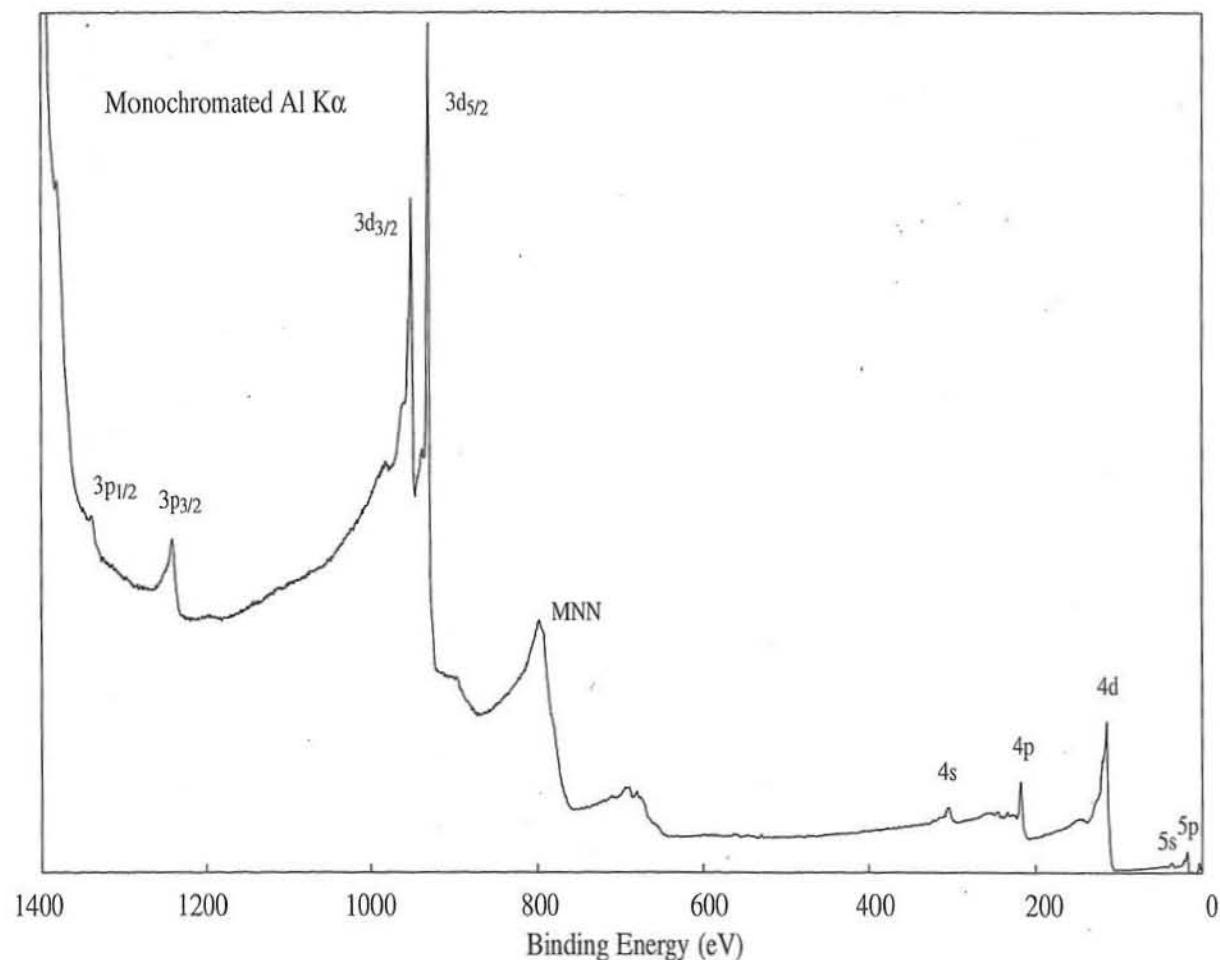
Compound Type	881	882	883	884	885	886
Ce						
CeAl <sub>2</sub>						
CePd <sub>3</sub>						
CeSe						
CeCu <sub>2</sub> Si <sub>2</sub>						
CeO <sub>2</sub>						
CeH <sub>3</sub>						



# Praseodymium Pr

Atomic Number 59

## Handbook of X-ray Photoelectron Spectroscopy

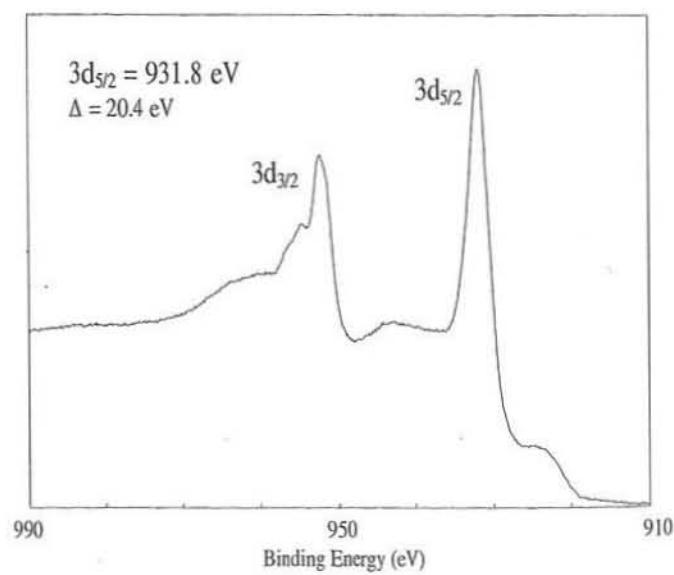
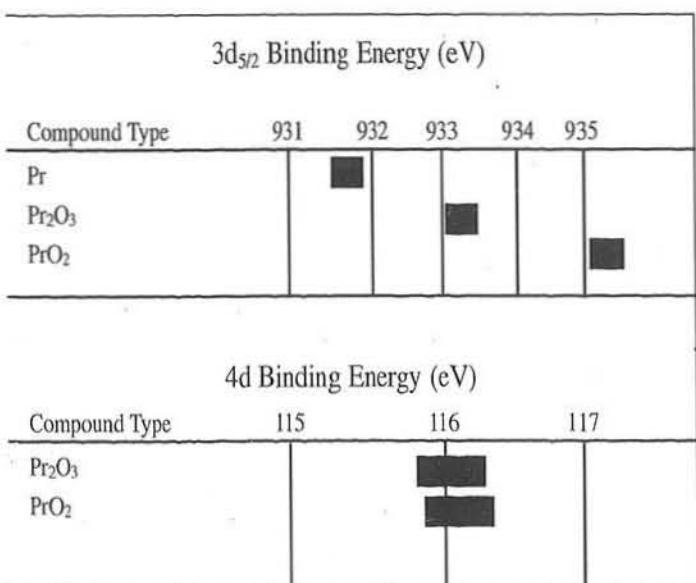
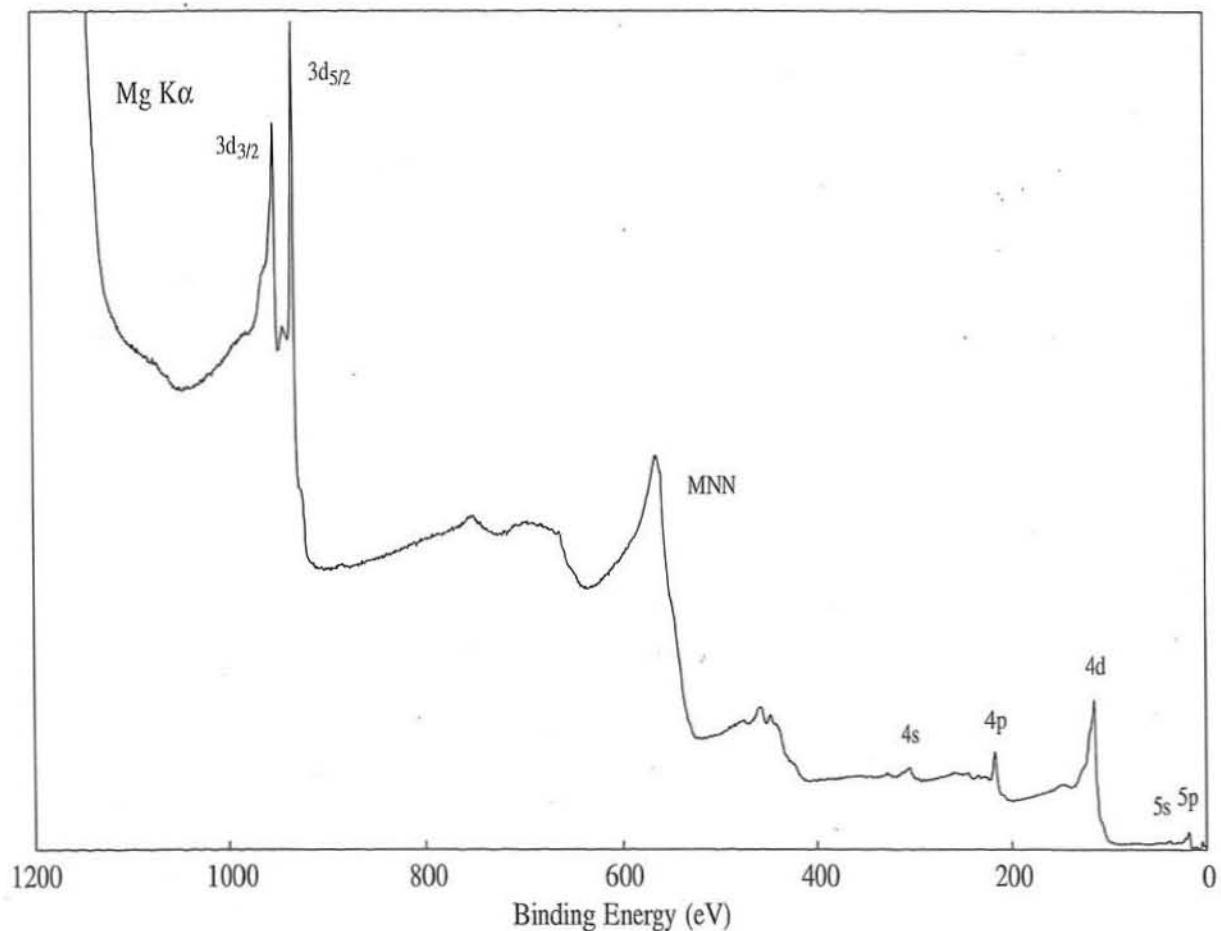


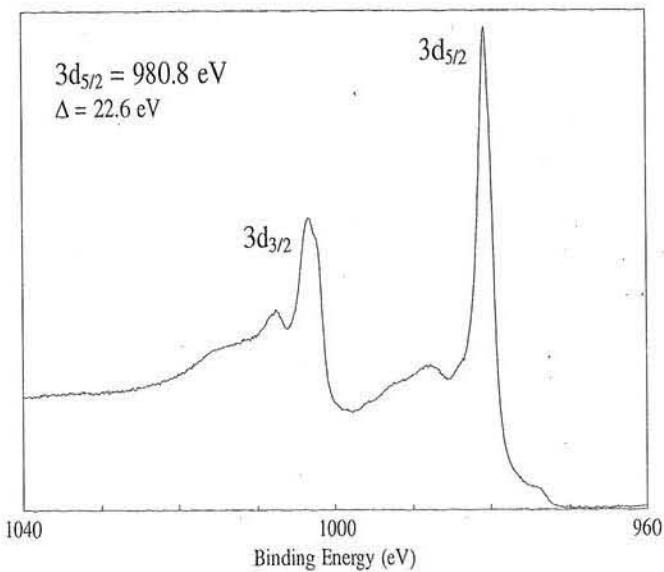
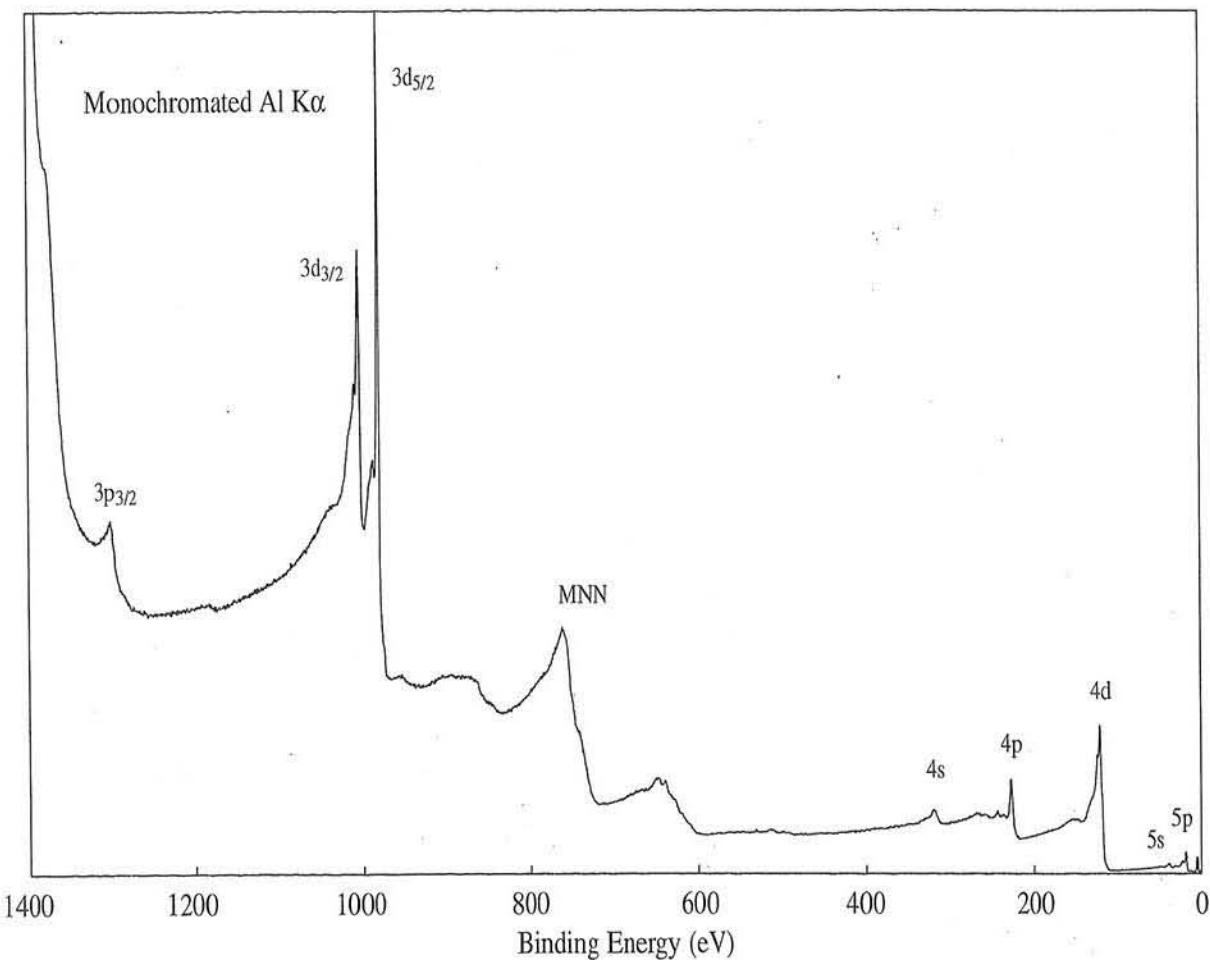
Line Positions (eV)					
Photoelectron Lines					
3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>		
1339	1242	952	932		
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d	5s	5p
305	234	218	115	38	18

---

Auger Lines

$M_{45}N_{45}N_{45}$	
797	(Al)
564	(Mg)





Line Positions (eV)

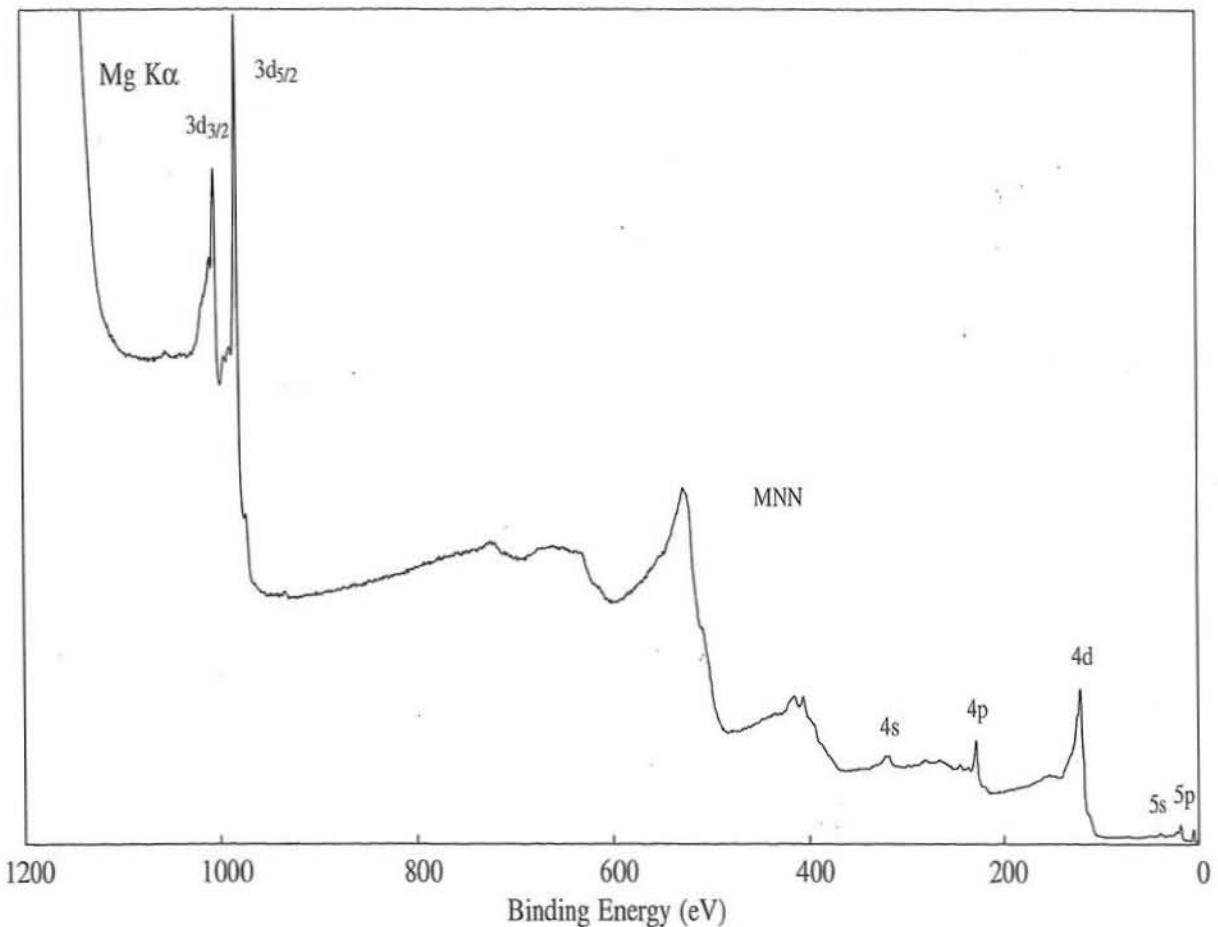
Photoelectron Lines

3p $_{3/2}$	3d $_{3/2}$	3d $_{5/2}$
1301	1003	981

Auger Lines

4s	4p $_{1/2}$	4p $_{3/2}$	4d	5s	5p
320	245	228	121	39	19

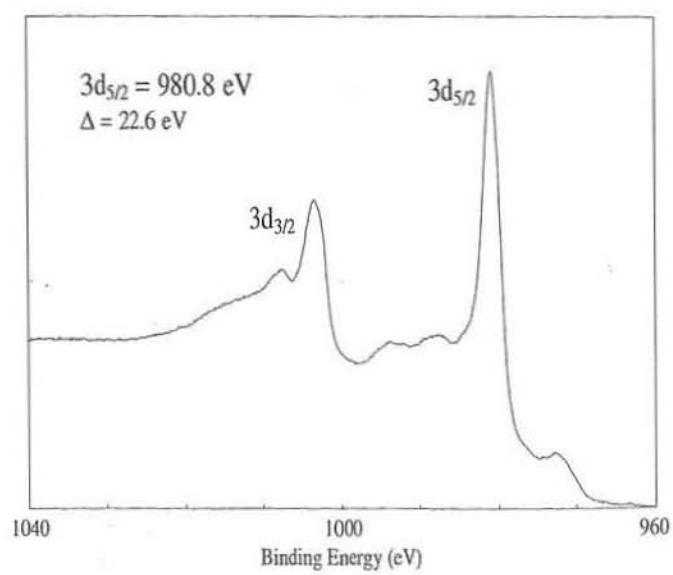
$M_{45}N_{45}N_{45}$   
758 (Al)  
525 (Mg)

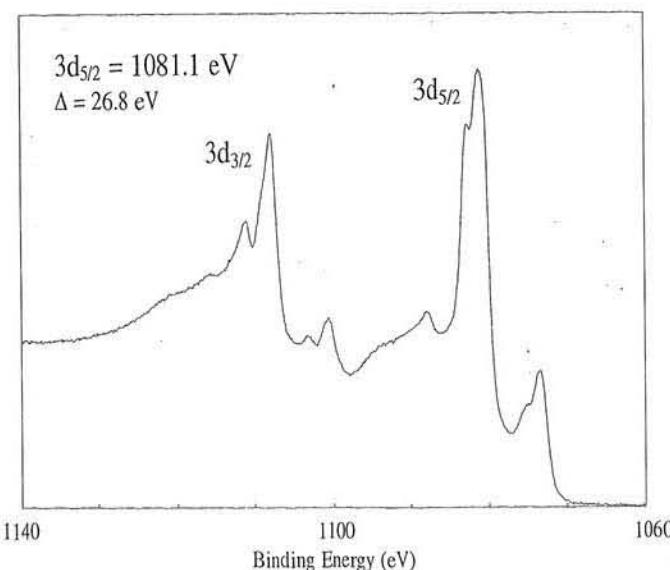
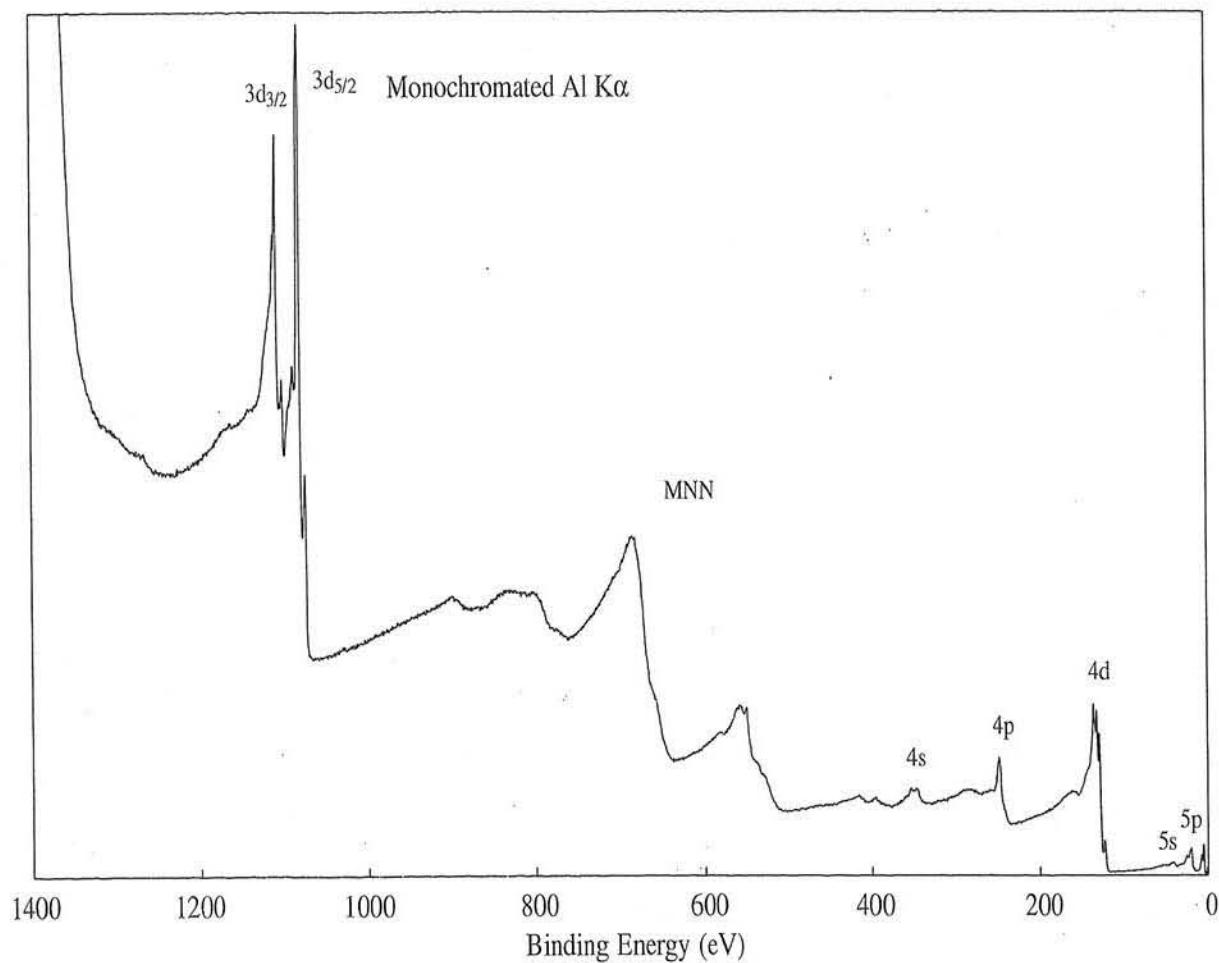


3d $_{5/2}$ Binding Energy (eV)			
Compound Type	980	981	982
Nd			
Nd <sub>2</sub> O <sub>3</sub>		■	

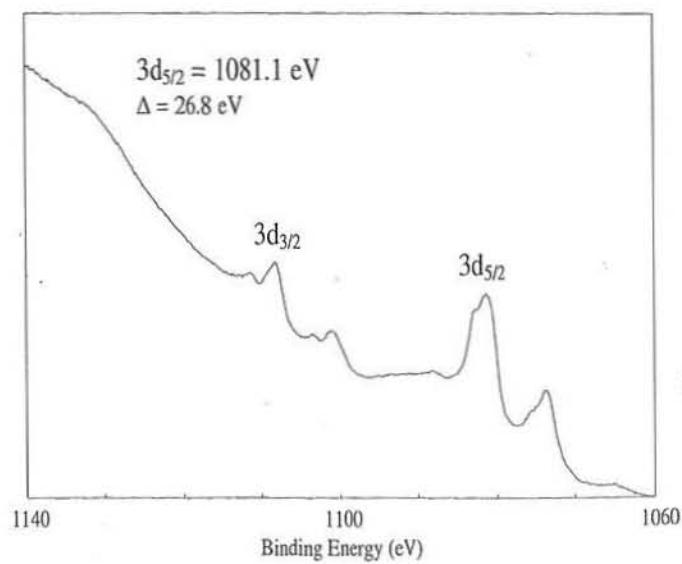
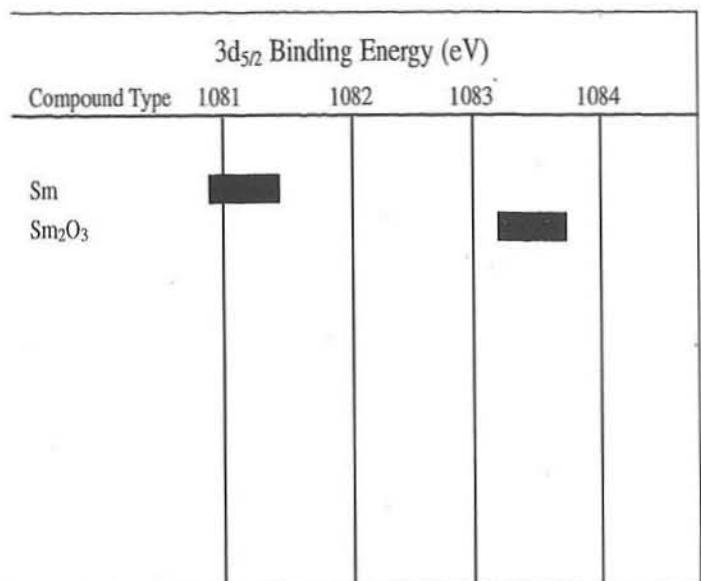
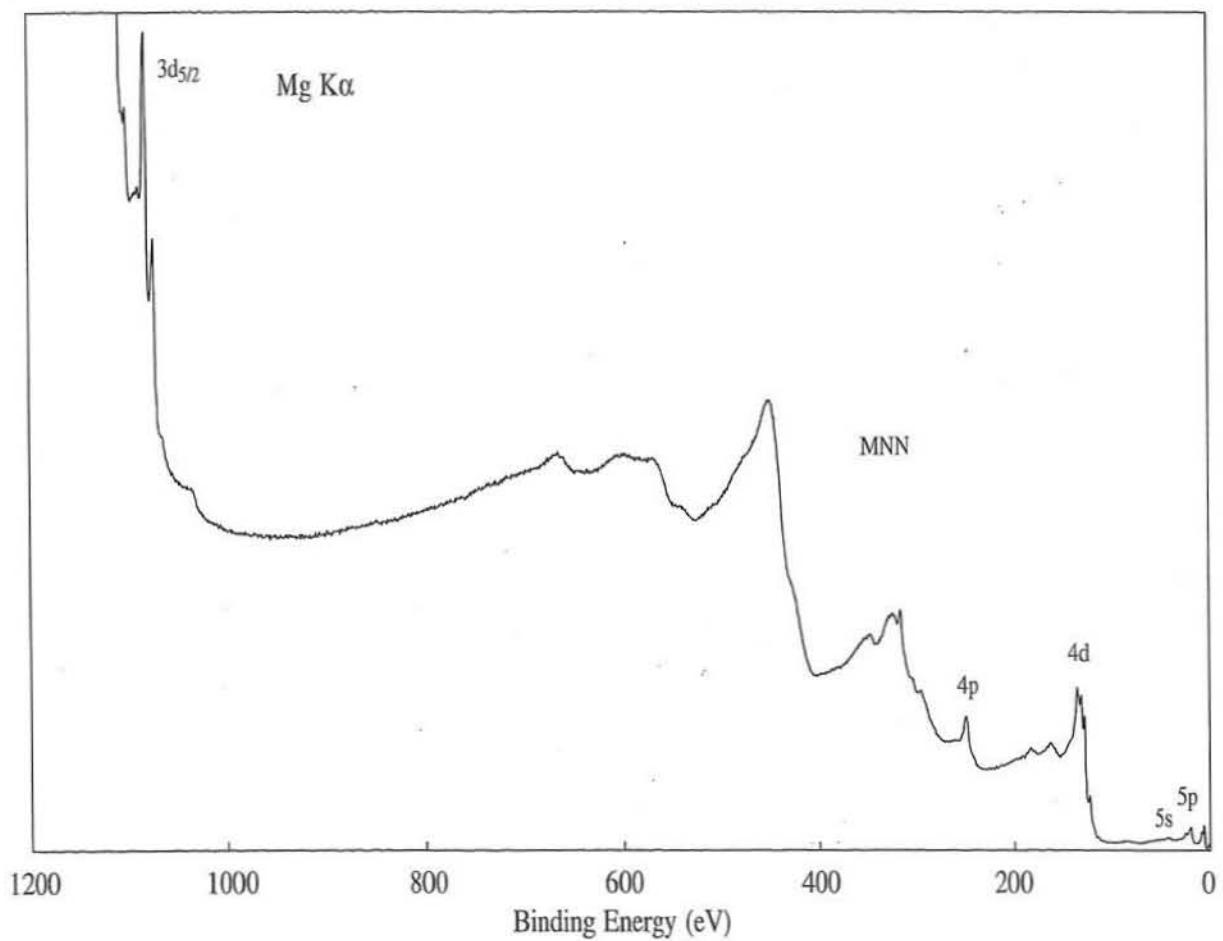
  

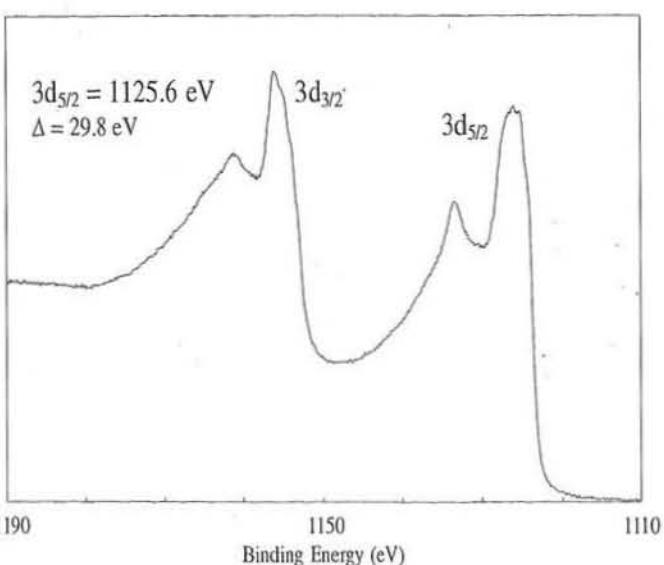
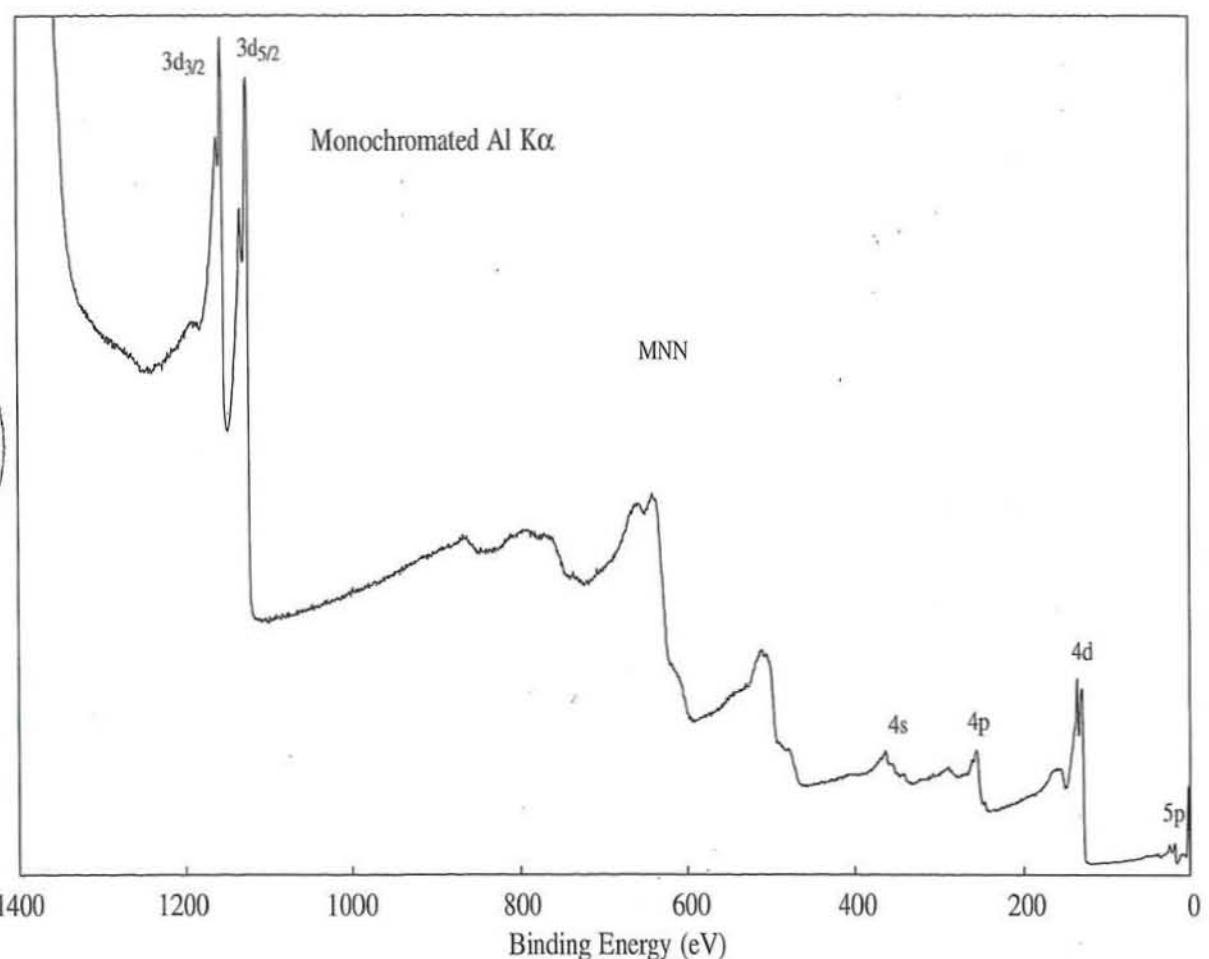
4d Binding Energy (eV)			
Compound Type	119	120	121
Nd <sub>2</sub> O <sub>3</sub>			■





Line Positions (eV)							
<u>Photoelectron Lines</u>							
3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d	5s	5p
1108	1081	349	283	250	129	41	19
<u>Auger Lines</u>							
M <sub>45</sub> N <sub>45</sub> N <sub>45</sub>							
682      (Al)							
449      (Mg)							

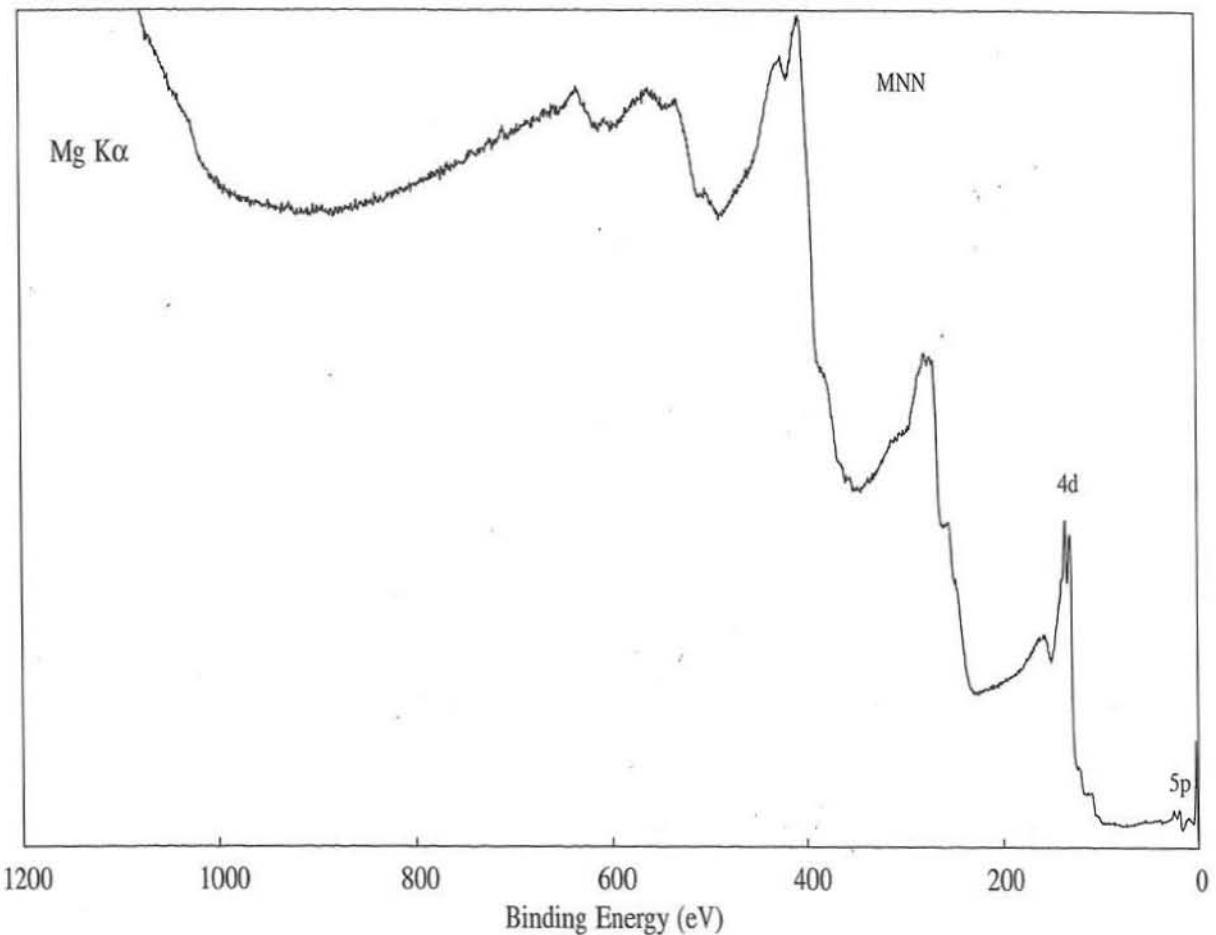




Line Positions (eV)							
Photoelectron Lines							
3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d	5s	5p
1155	1126	363	289	255	128	39	19

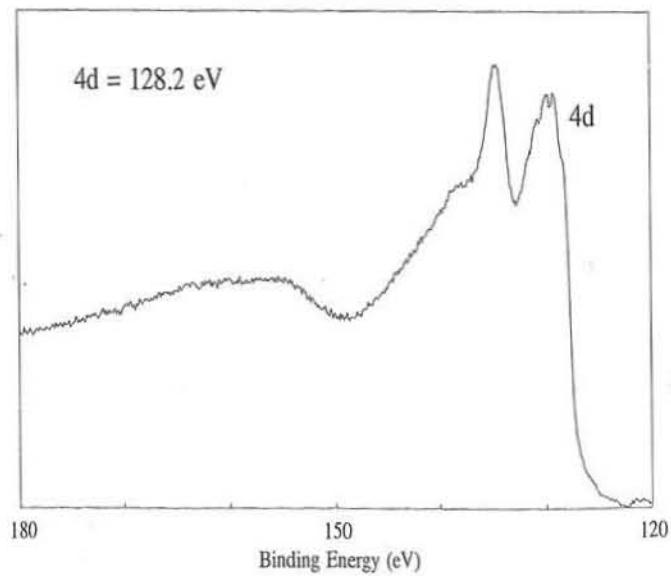
Auger Lines							
$M_{45}N_{45}N_{45}$							
637	(Al)						
404	(Mg)						

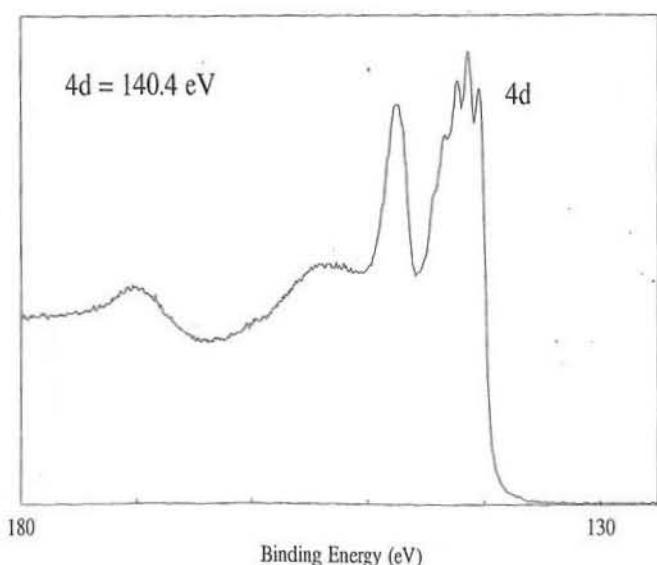
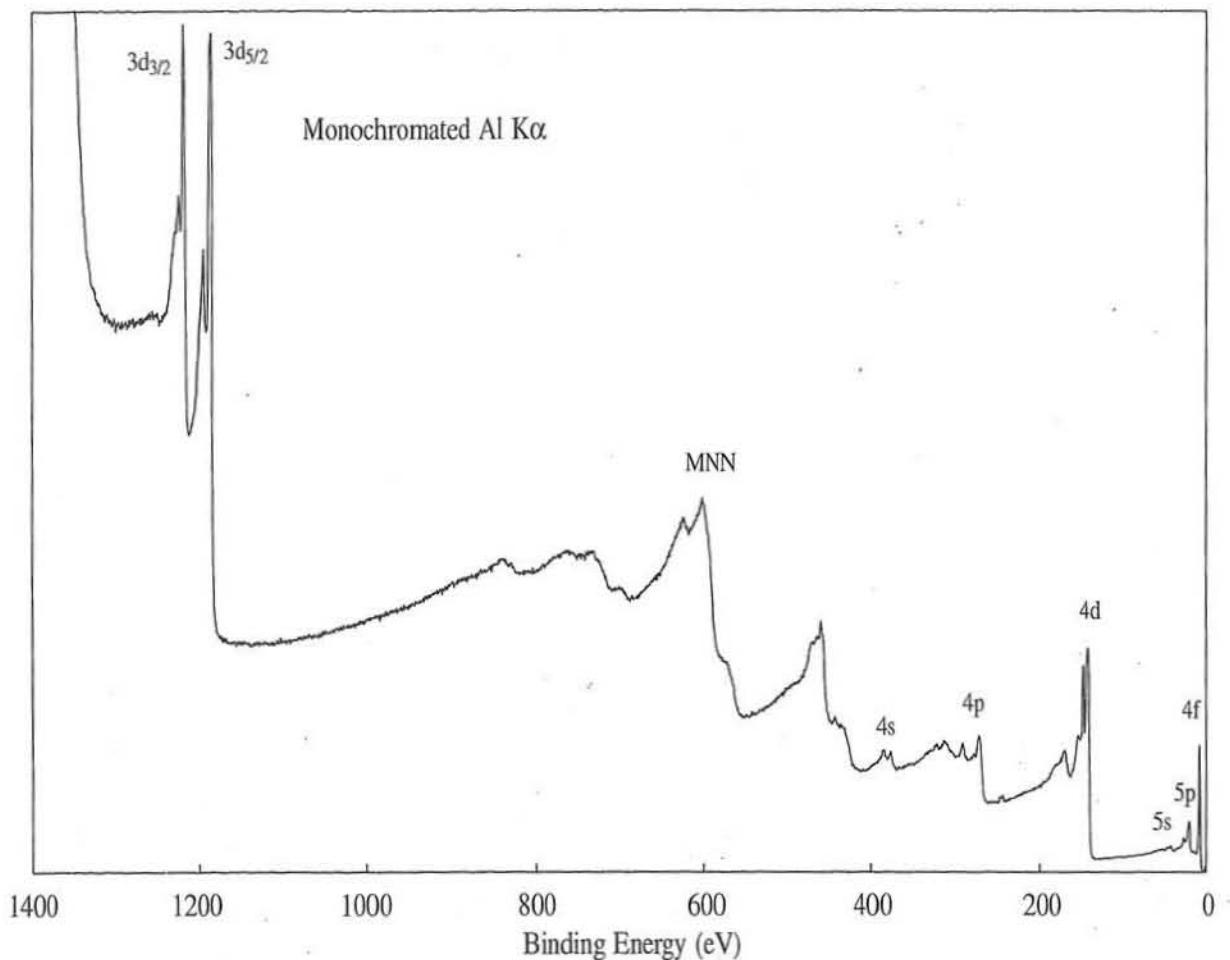


3d <sub>5/2</sub> Binding Energy (eV)							
Compound Type	1123	1124	1125	1126	1127	1128	1129
Eu				■			

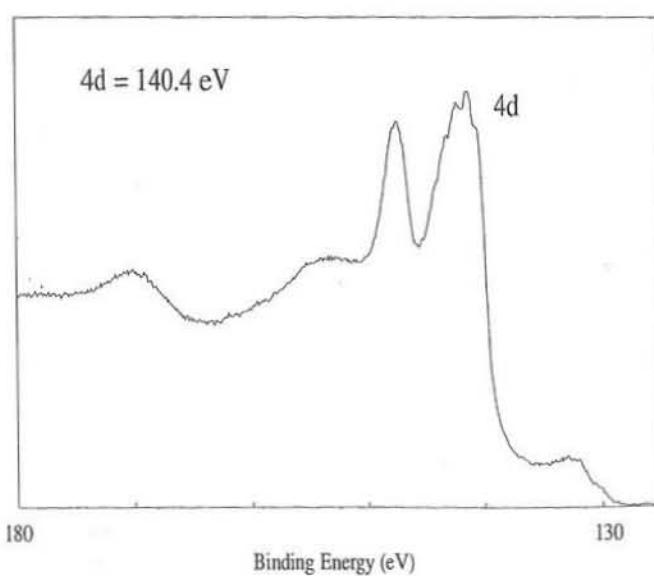
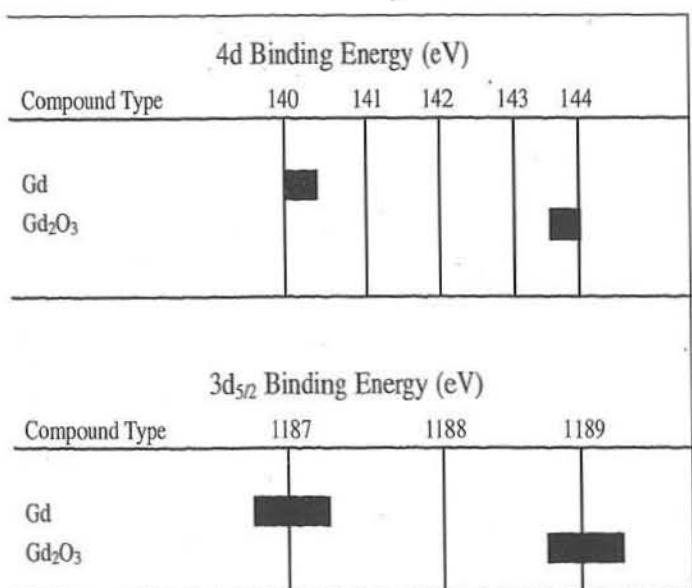
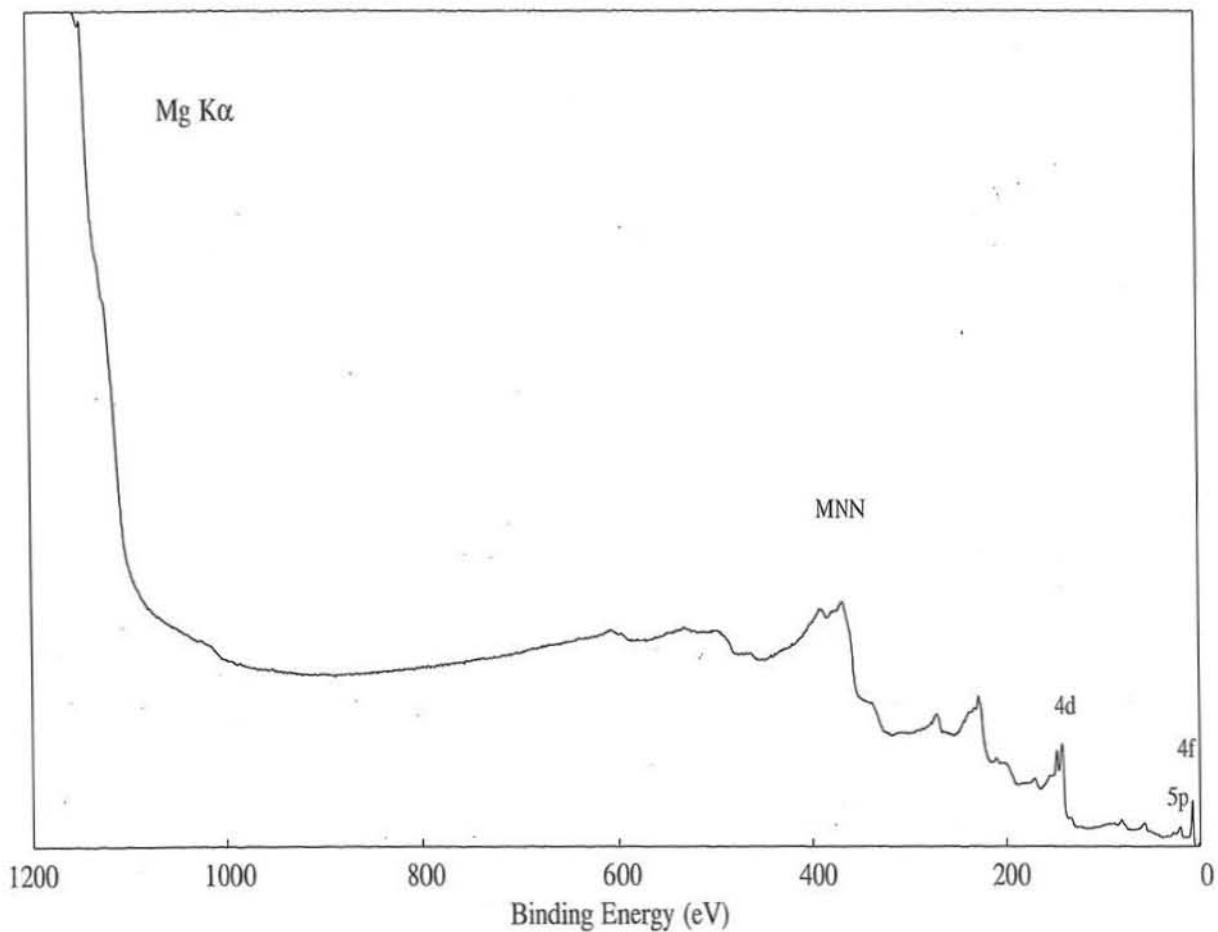
  

4d Binding Energy (eV)							
Compound Type	128	129	130	131	132	133	134
Eu	■						
Eu <sub>2</sub> O <sub>3</sub>						■	



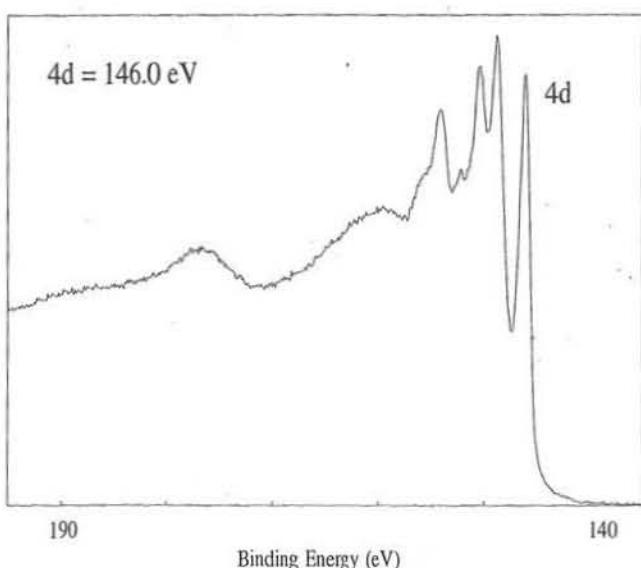
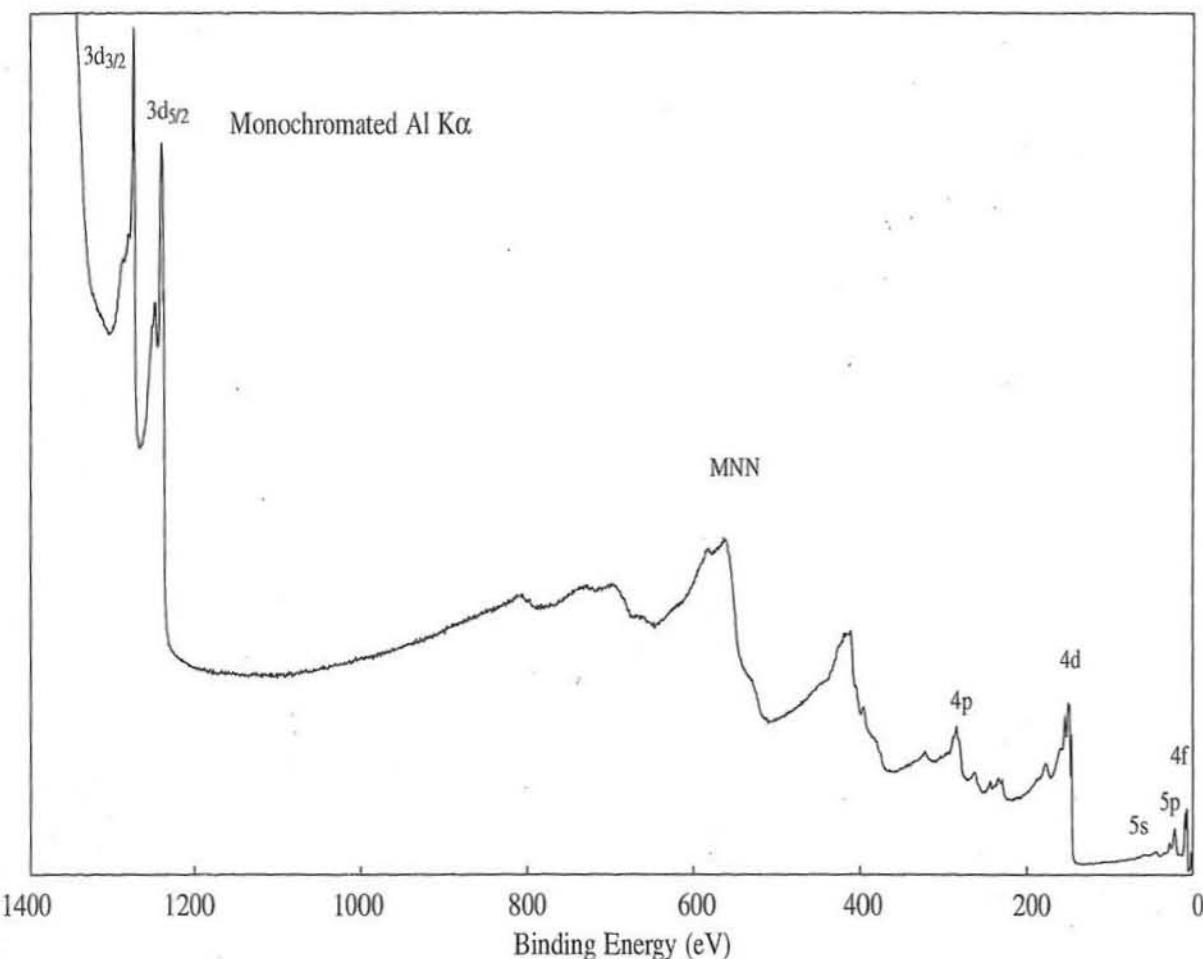


Line Positions (eV)							
<u>Photoelectron Lines</u>							
3d <sub>3/2</sub>	3d <sub>5/2</sub>						
1218	1186						
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d	5s	5p	4f	
378	291	272	140	43	21	8	
<u>Auger Lines</u>							
M <sub>45</sub> N <sub>45</sub> N <sub>45</sub>							
602	(Al)						
369	(Mg)						



**Terbium Tb**  
Atomic Number 65

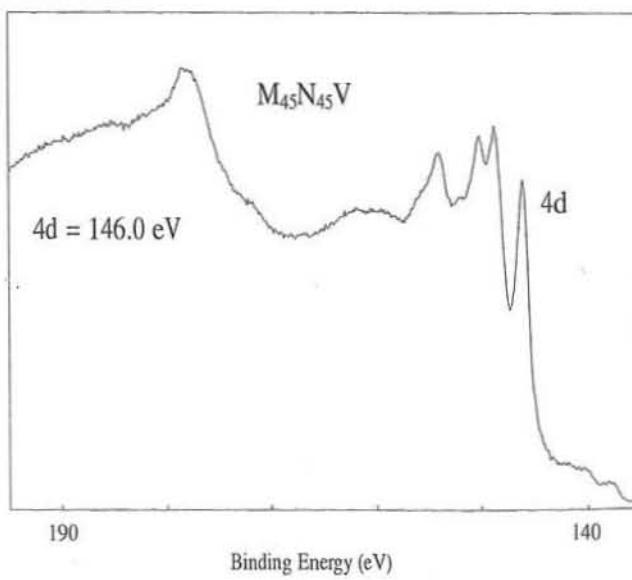
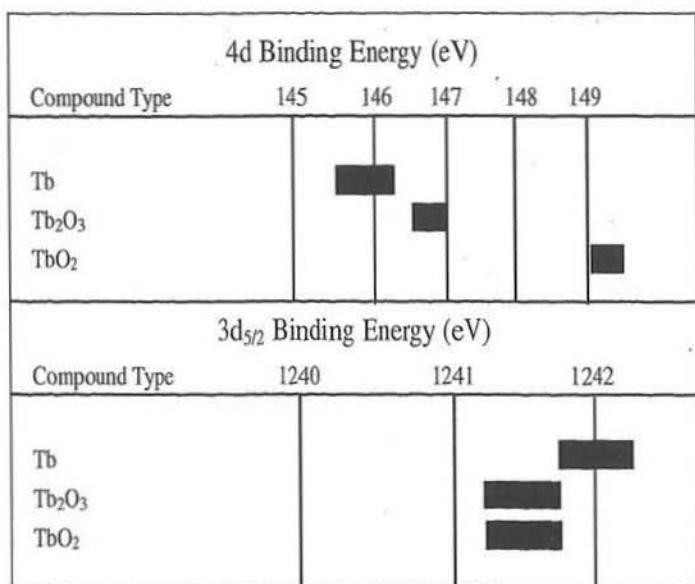
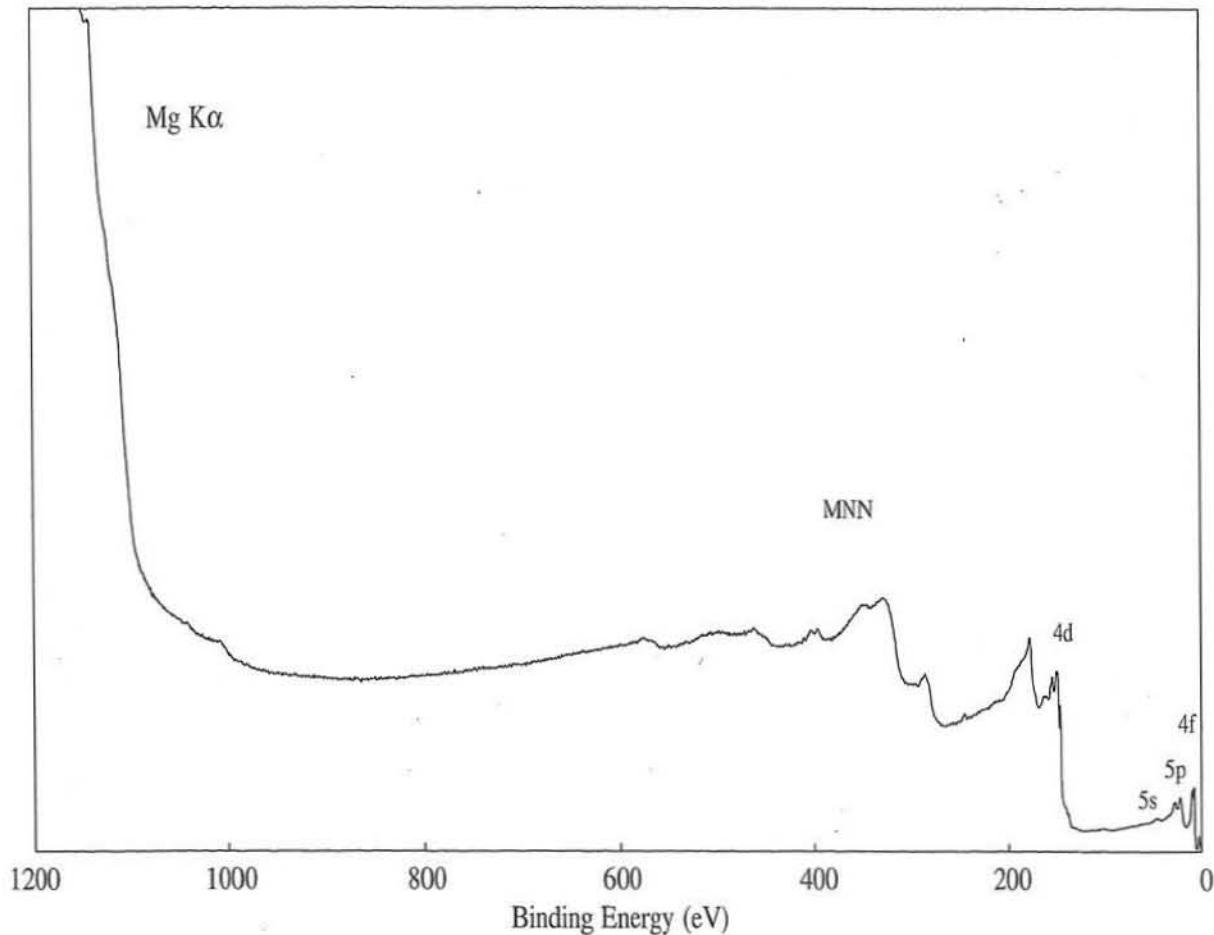
Handbook of X-ray Photoelectron Spectroscopy

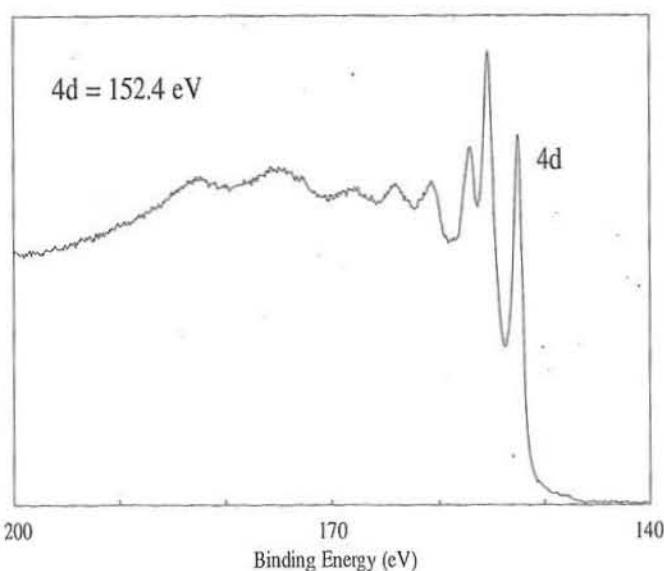
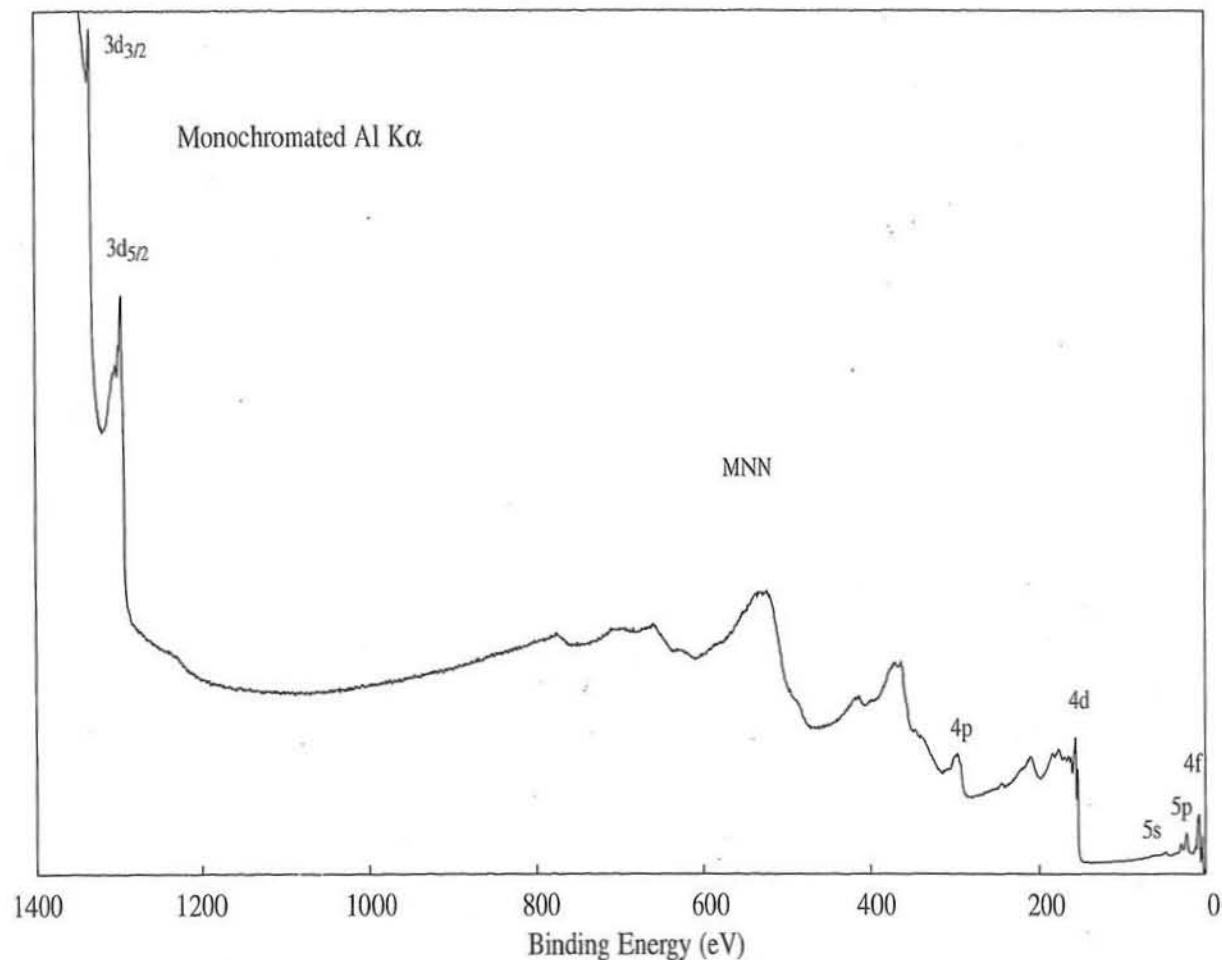


Line Positions (eV)							
Photoelectron Lines							
$3d_{3/2}$	$3d_{5/2}$						
1276	1241						
4s	$4p_{1/2}$	$4p_{3/2}$	4d	5s	5p	4f	
396	322	285	146	45	22	8	
Auger Lines							
$M_{45}N_{45}N_{45}$	$M_{45}N_{45}V$	$M_5VV$	$M_4VV$				
559	411	260	230				
326	178		(Al) (Mg)				

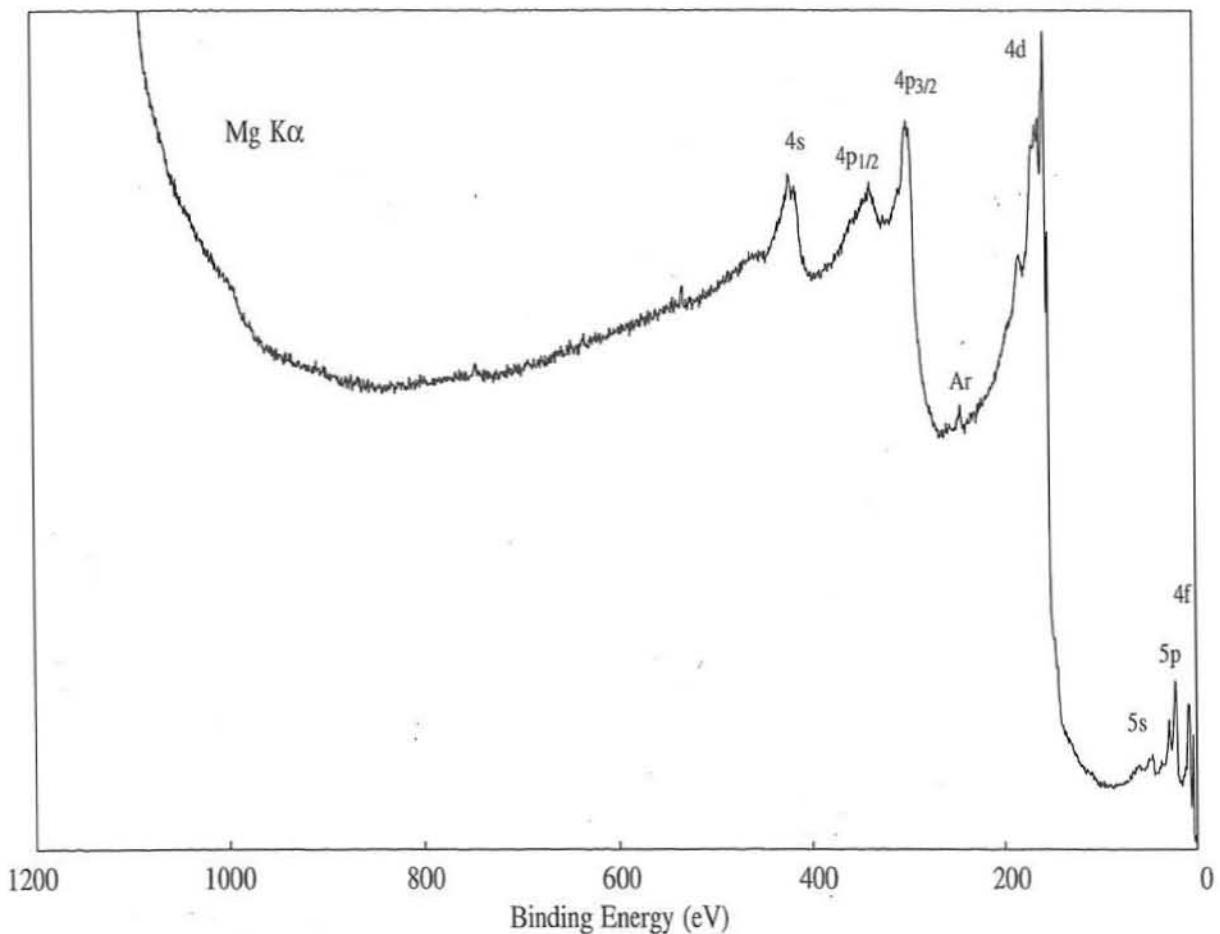


Perkin-Elmer Corporation  
Physical Electronics Division





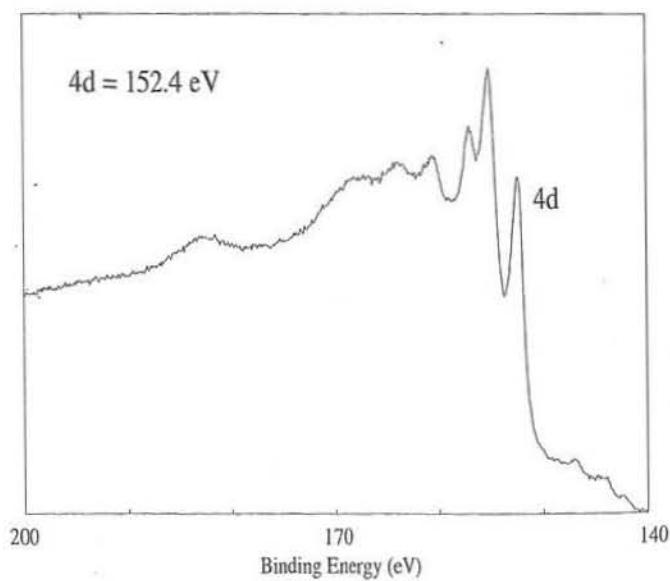
Line Positions (eV)							
Photoelectron Lines							
3d <sub>3/2</sub>	3d <sub>5/2</sub>						
1333	1296						
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d	5s	5p	4f	
417	337	297	152	48	23	8	
Auger Lines							
M <sub>45</sub> N <sub>45</sub> N <sub>45</sub>			M <sub>45</sub> N <sub>45</sub> V				
526			368	(Al)			



4d Binding Energy (eV)					
Compound Type	152	156	160	164	168
Dy					
$\text{Dy}_2\text{O}_3$	■				■

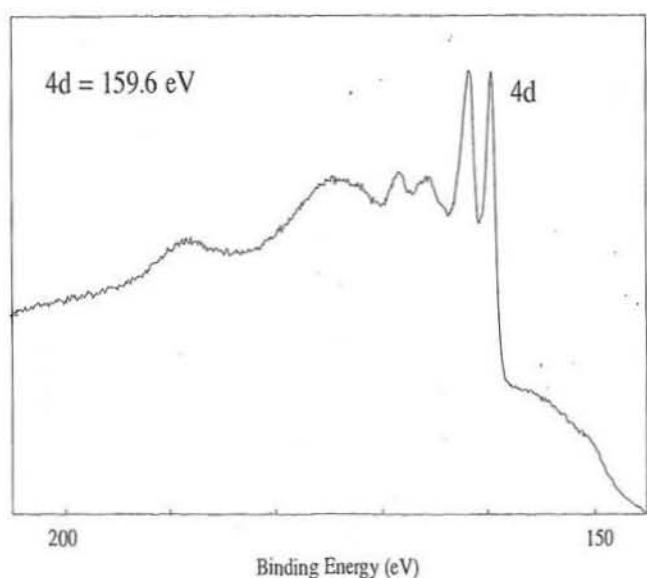
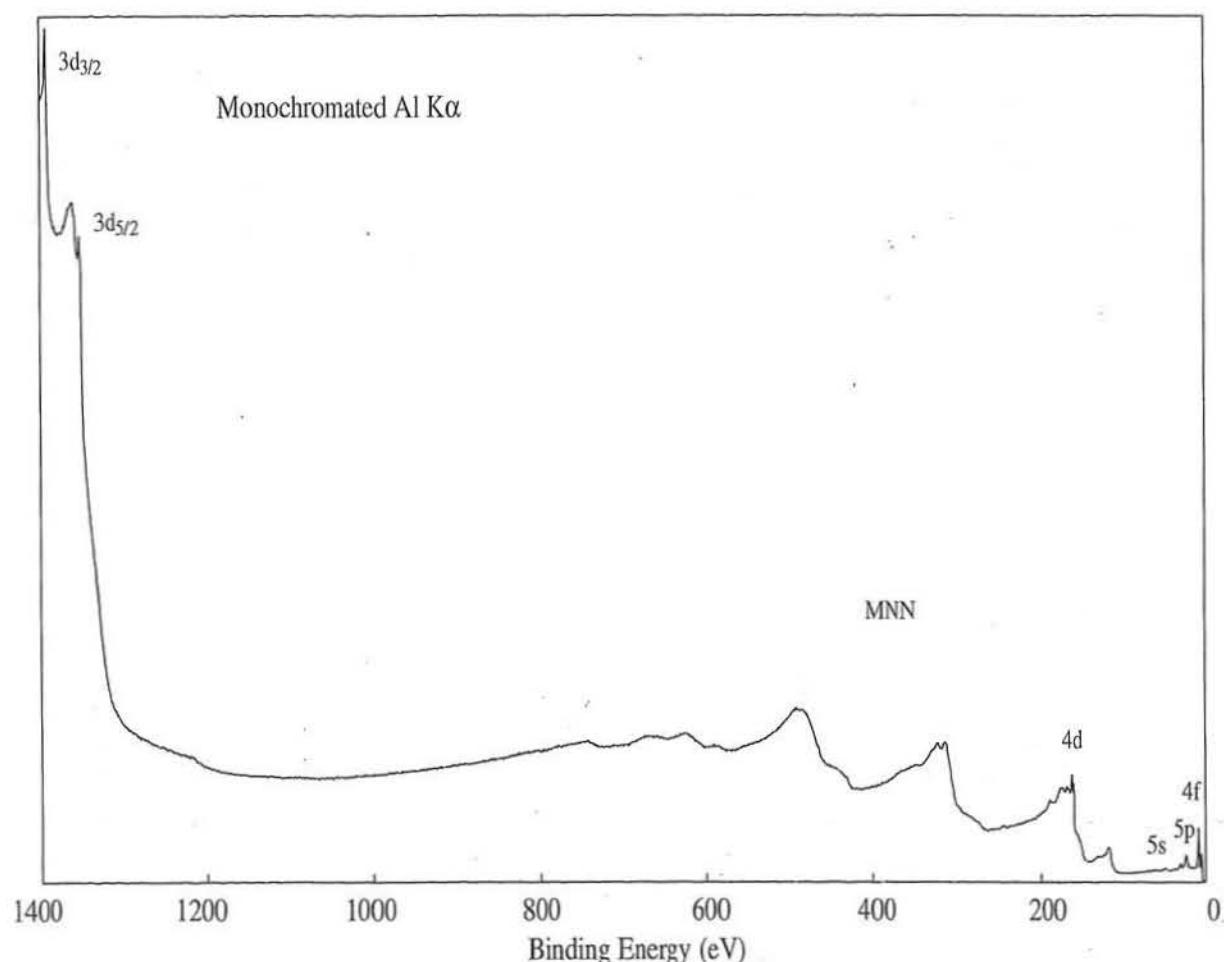
3d <sub>5/2</sub> Binding Energy (eV)					
Compound Type	1287	1289	1291	1293	1295
Dy					
$\text{Dy}_2\text{O}_3$		■			■



# Holmium Ho

Atomic Number 67

## Handbook of X-ray Photoelectron Spectroscopy

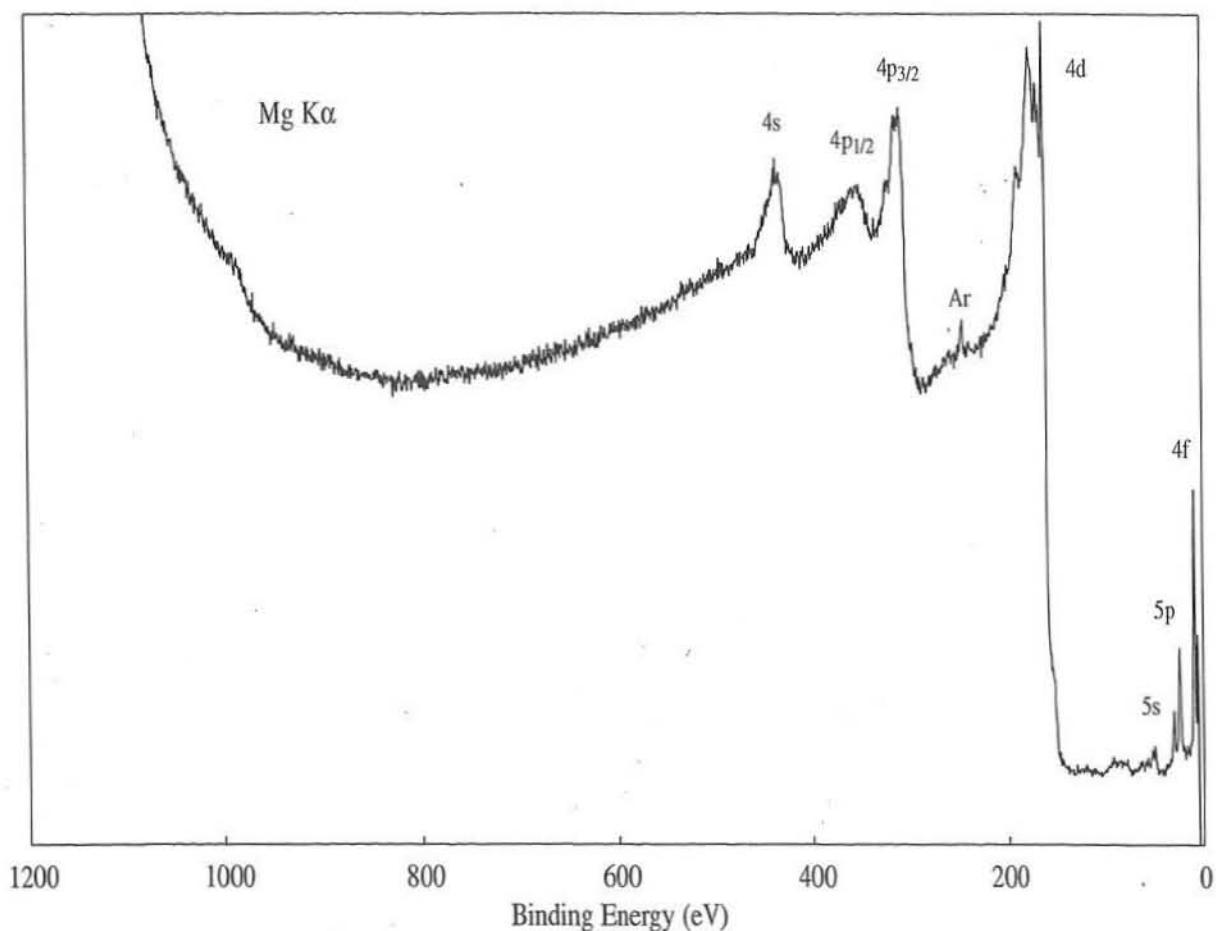


Line Positions (eV)					
Photoelectron Lines					
3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d
1393	1352	435	353	309	160
5s	5p <sub>1/2</sub>	5p <sub>3/2</sub>	4f		
49	30	24	9		

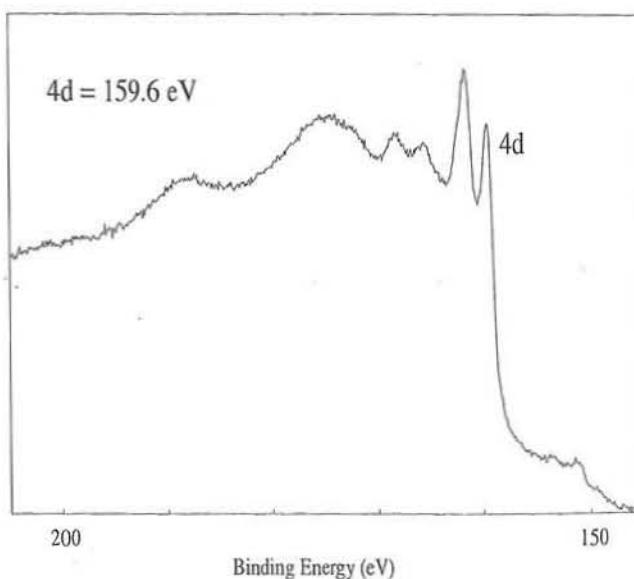
  

Auger Lines		
M <sub>45</sub> N <sub>45</sub> N <sub>45</sub>	M <sub>45</sub> N <sub>45</sub> V	M <sub>4</sub> VV (Al)

488      314      117

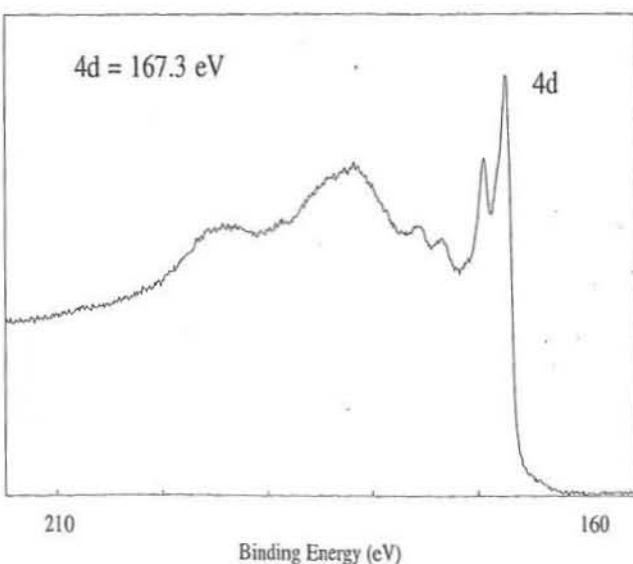
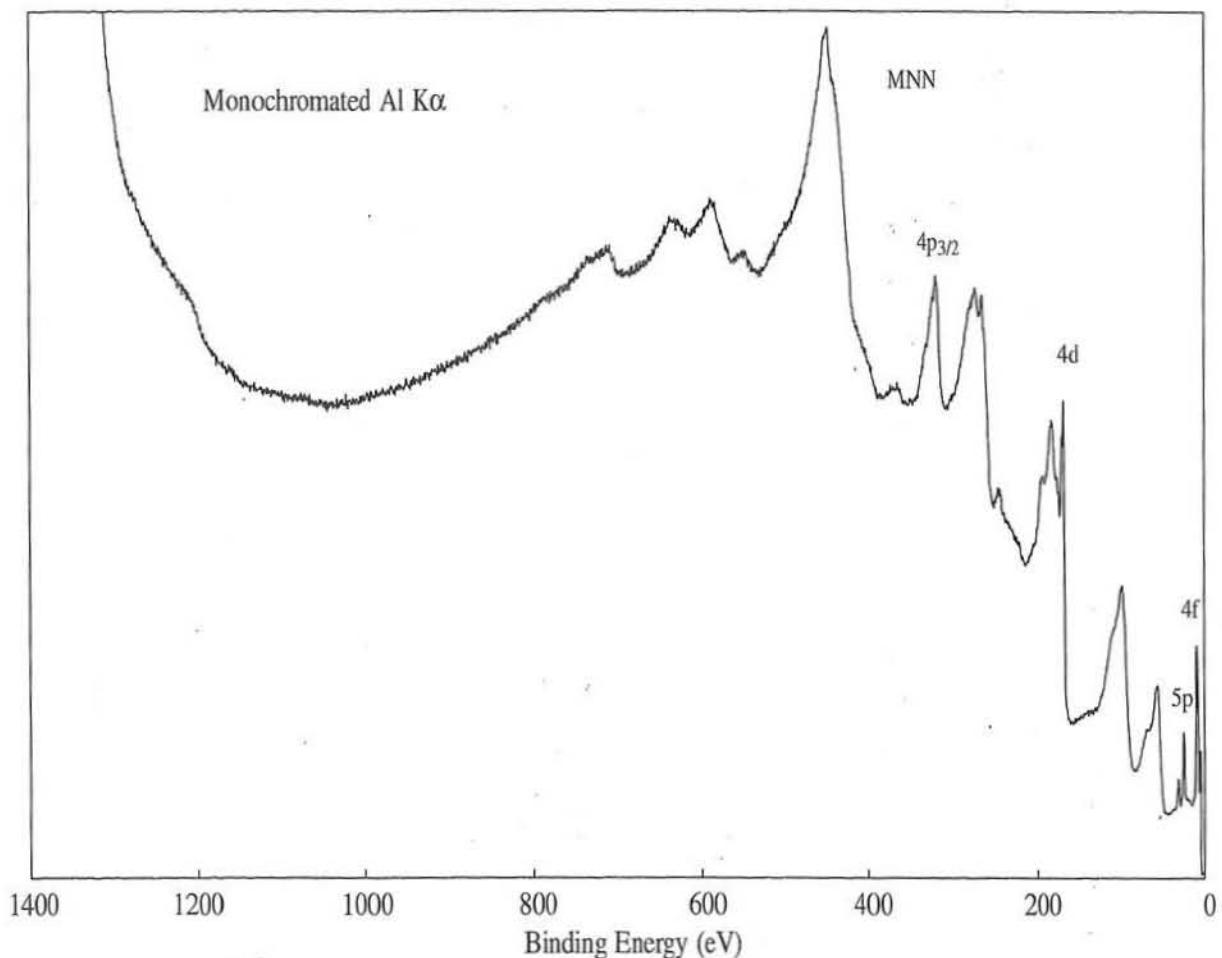


4d Binding Energy (eV)				
Compound Type	158	159	160	
Ho			█	

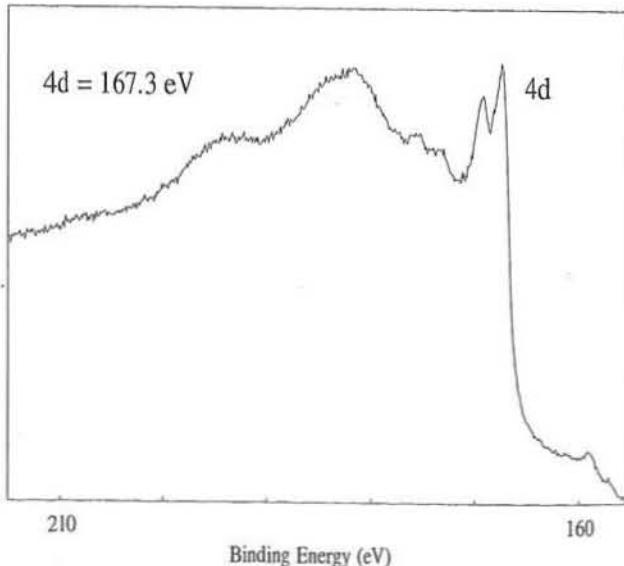
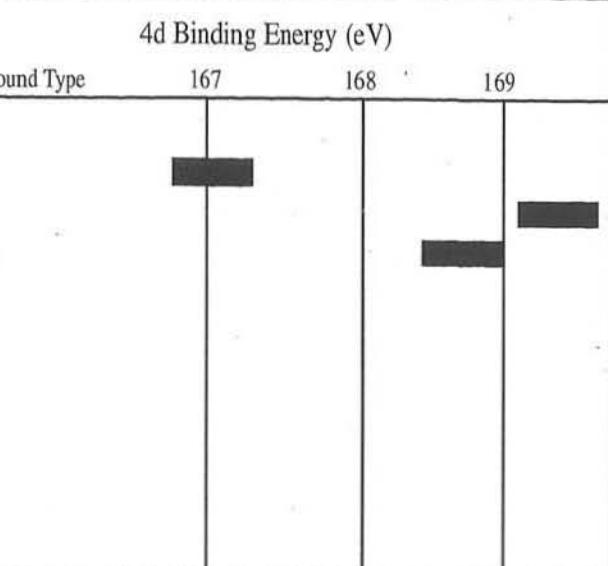
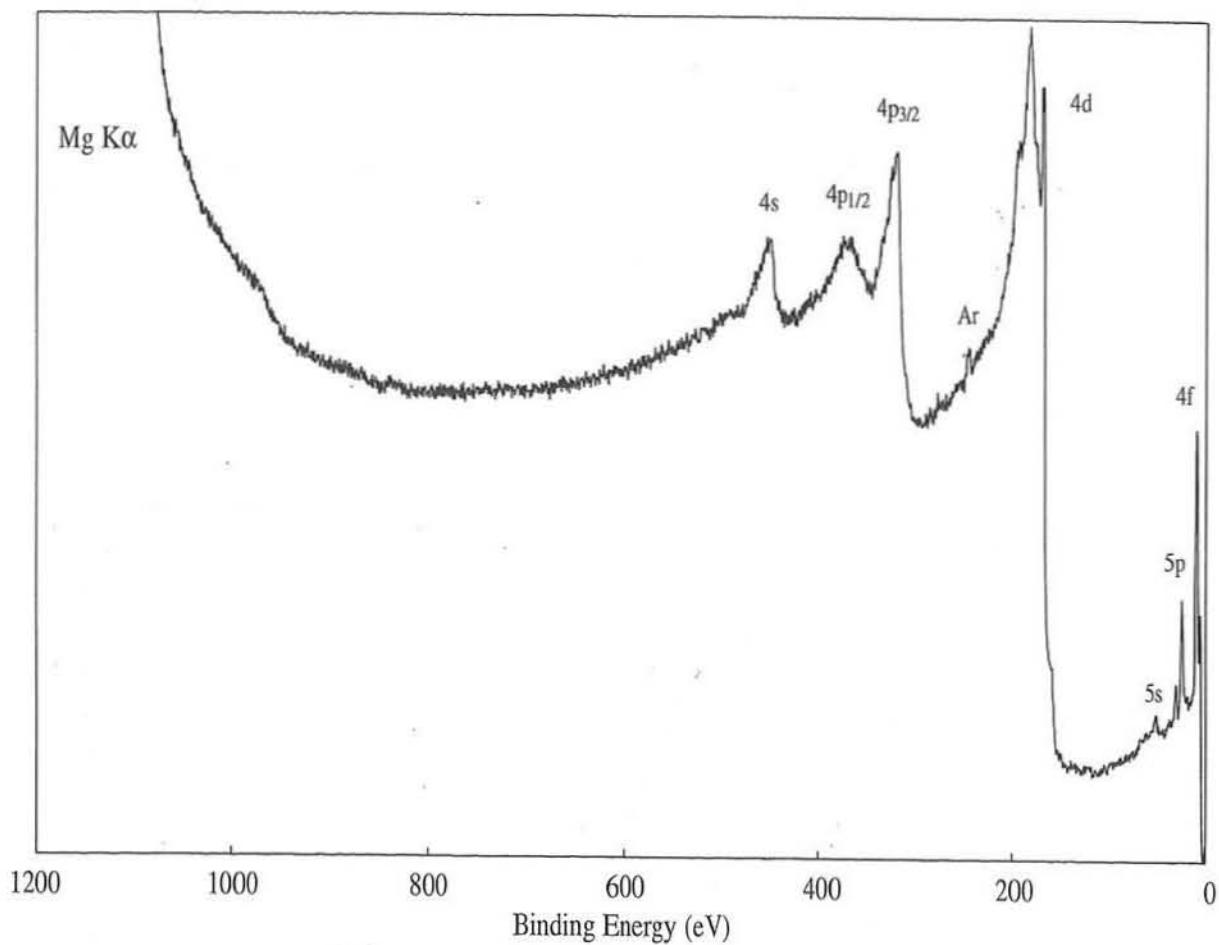


**Erbium      Er**

Atomic Number 68

**Handbook of X-ray Photoelectron Spectroscopy**

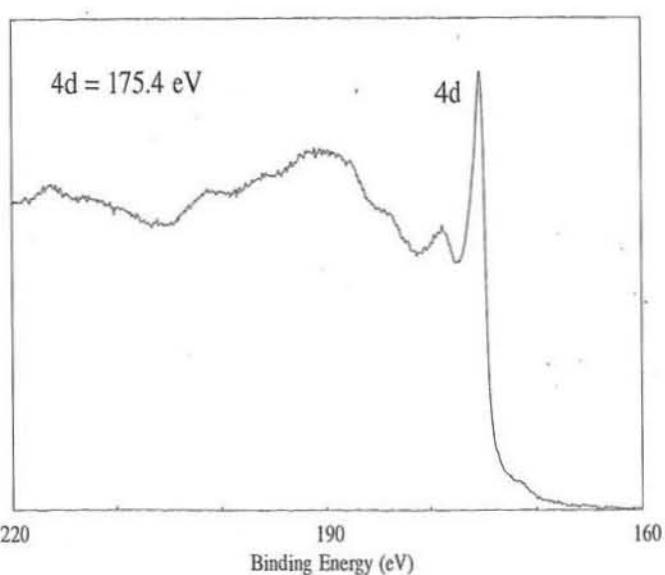
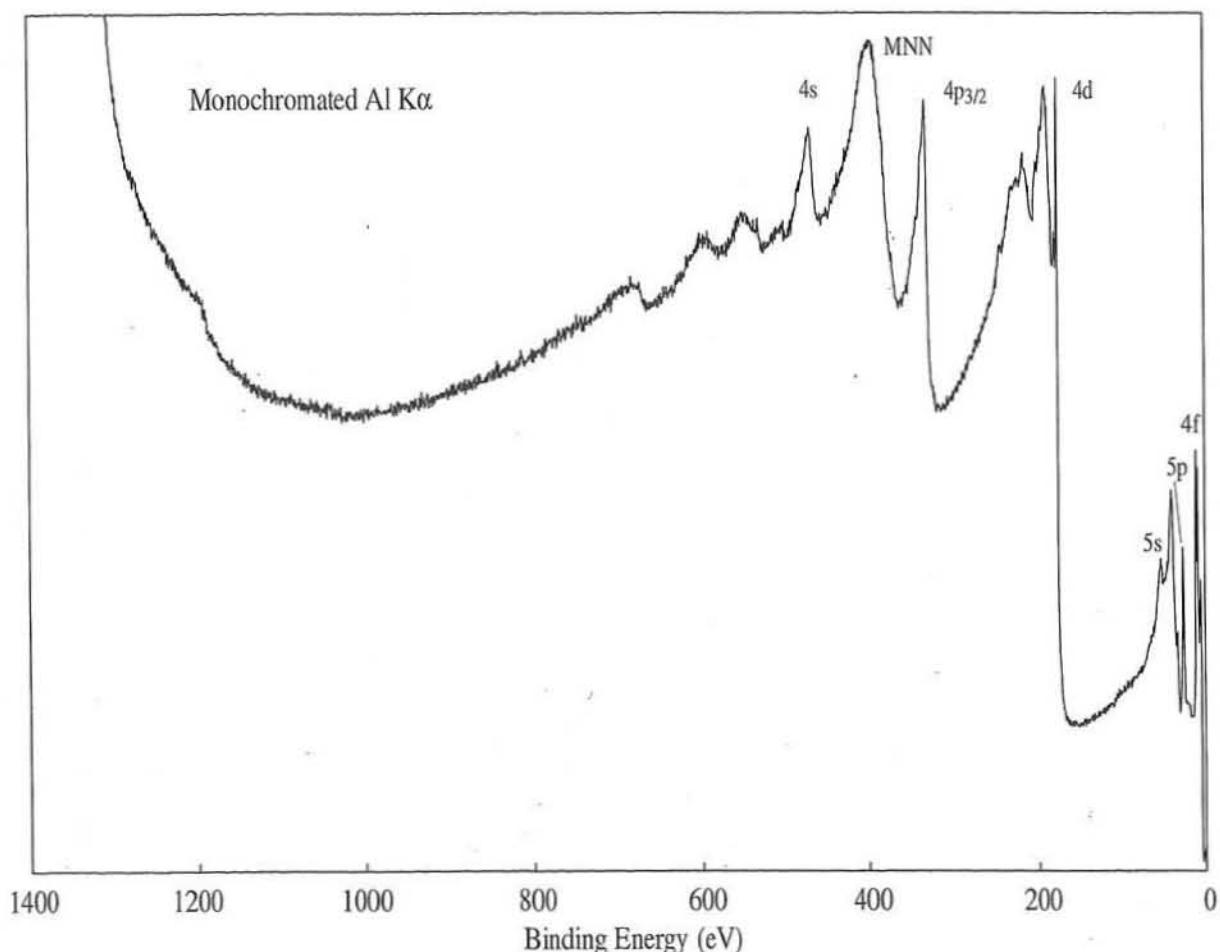
Line Positions (eV)							
Photoelectron Lines							
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d	5s	5p <sub>1/2</sub>	5p <sub>3/2</sub>	4f
451	368	321	167	52	31	24	9
Auger Lines							
M <sub>45</sub> N <sub>45</sub> N <sub>45</sub>		M <sub>45</sub> N <sub>45</sub> V		M <sub>5</sub> VV		M <sub>4</sub> VV	
440		273		98		56	(Al)



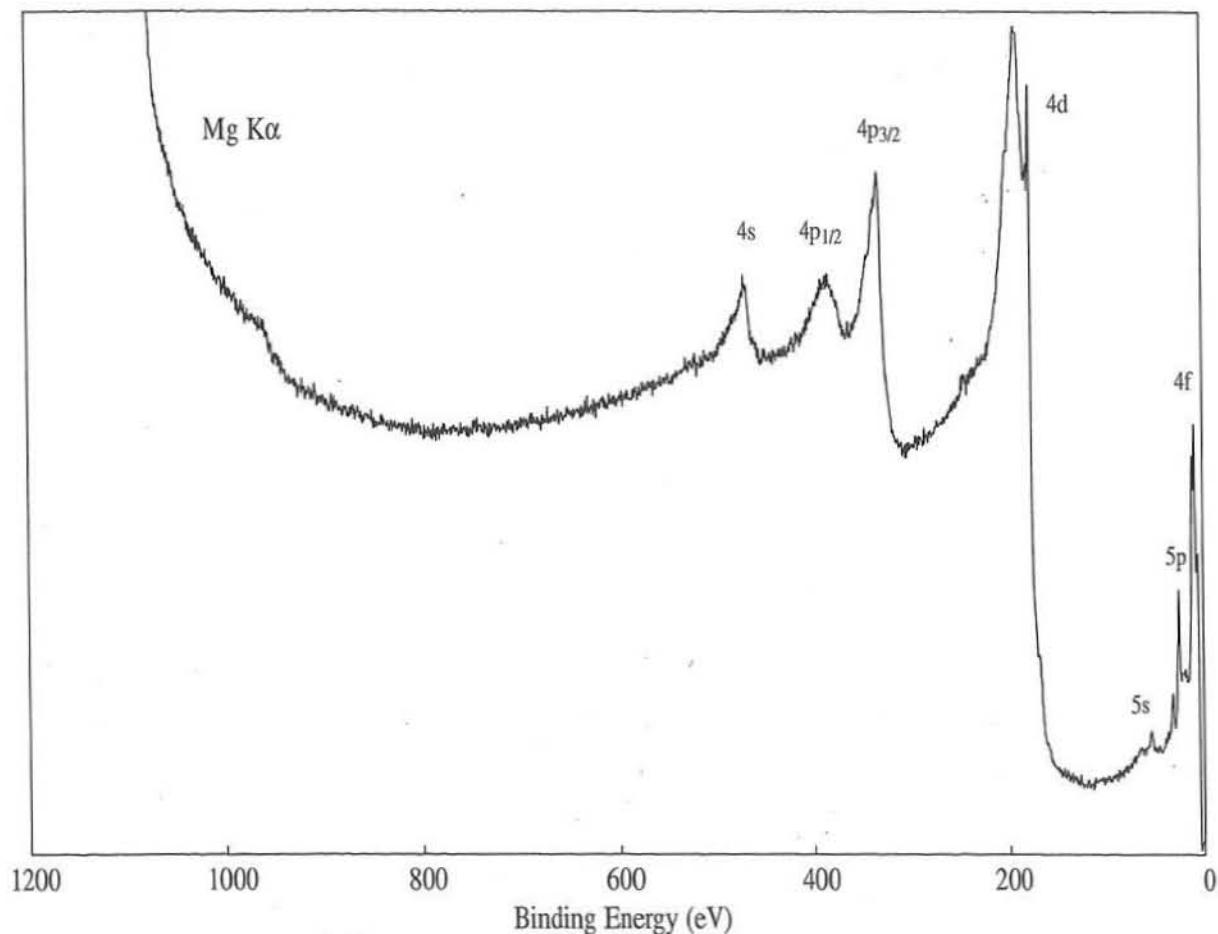
# Thulium Tm

Atomic Number 69

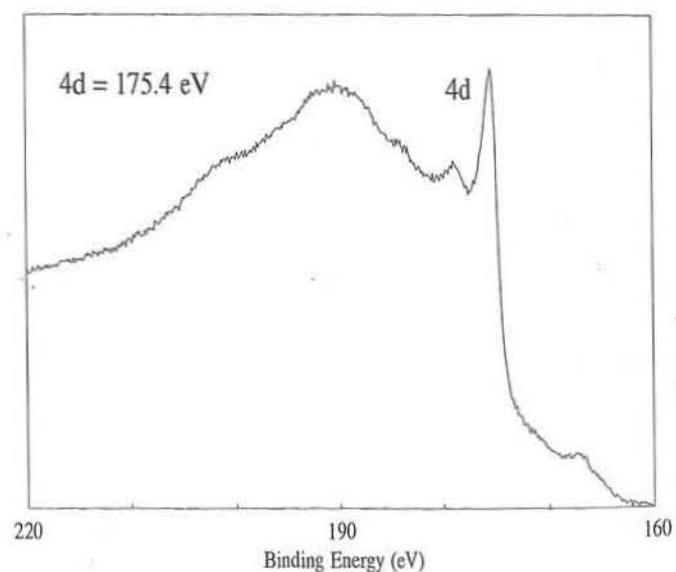
## Handbook of X-ray Photoelectron Spectroscopy

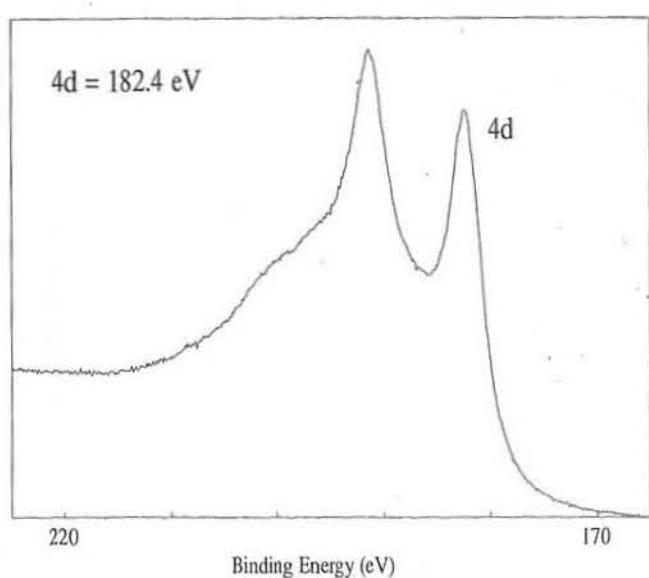
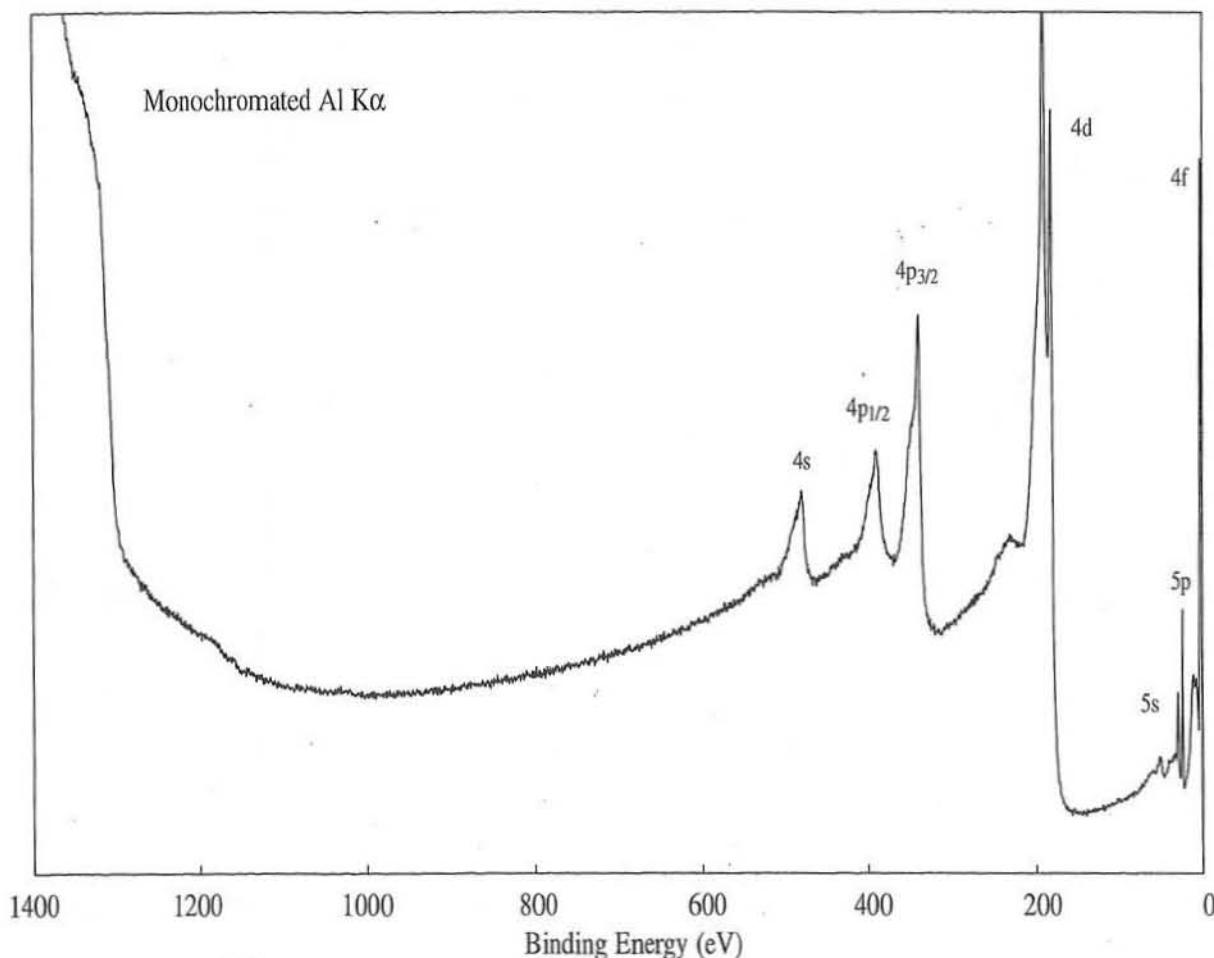


Line Positions (eV)							
Photoelectron Lines							
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d	5s	5p <sub>1/2</sub>	5p <sub>3/2</sub>	4f
470	384	333	175	53	32	25	8
Auger Lines							
$M_{45}N_{45}N_{45}$							
398 (Al)							



	4d Binding Energy (eV)		
Compound Type	174	175	176
Tm			

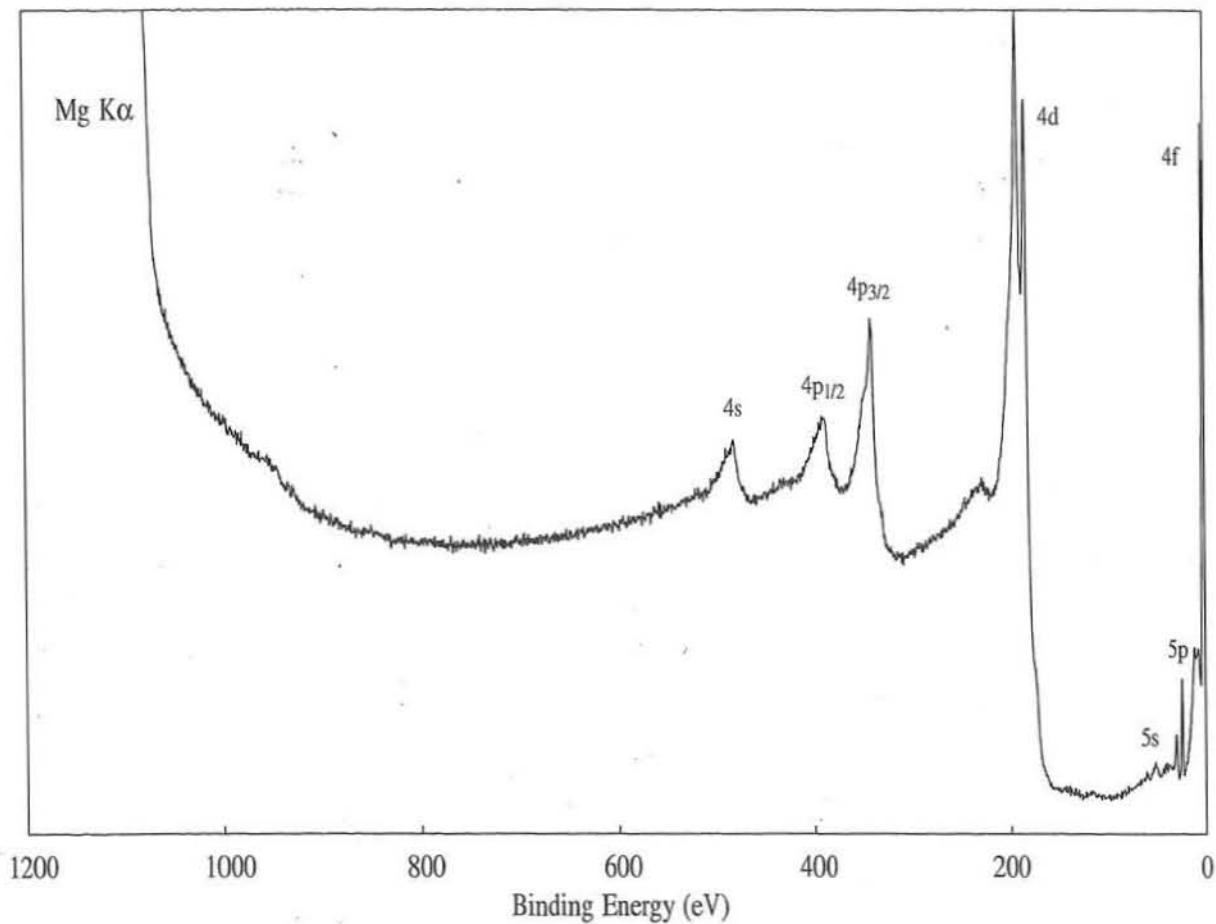




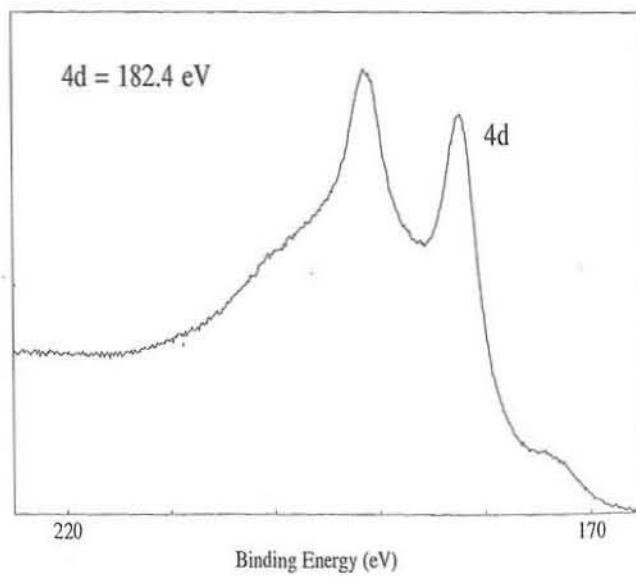
Line Positions (eV)

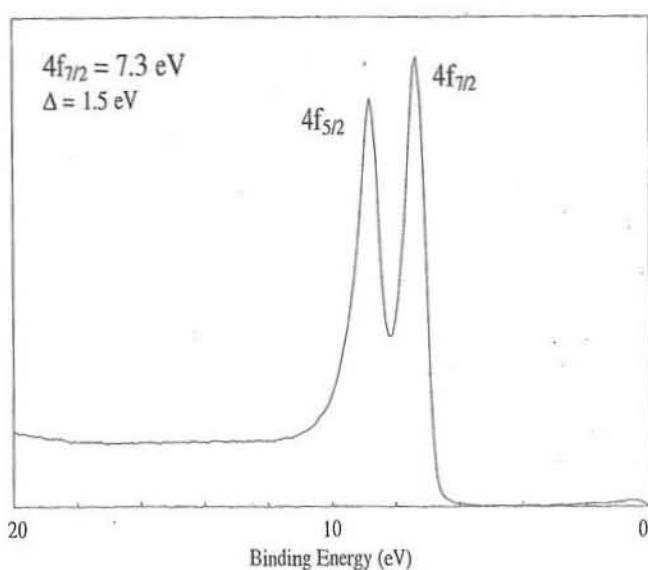
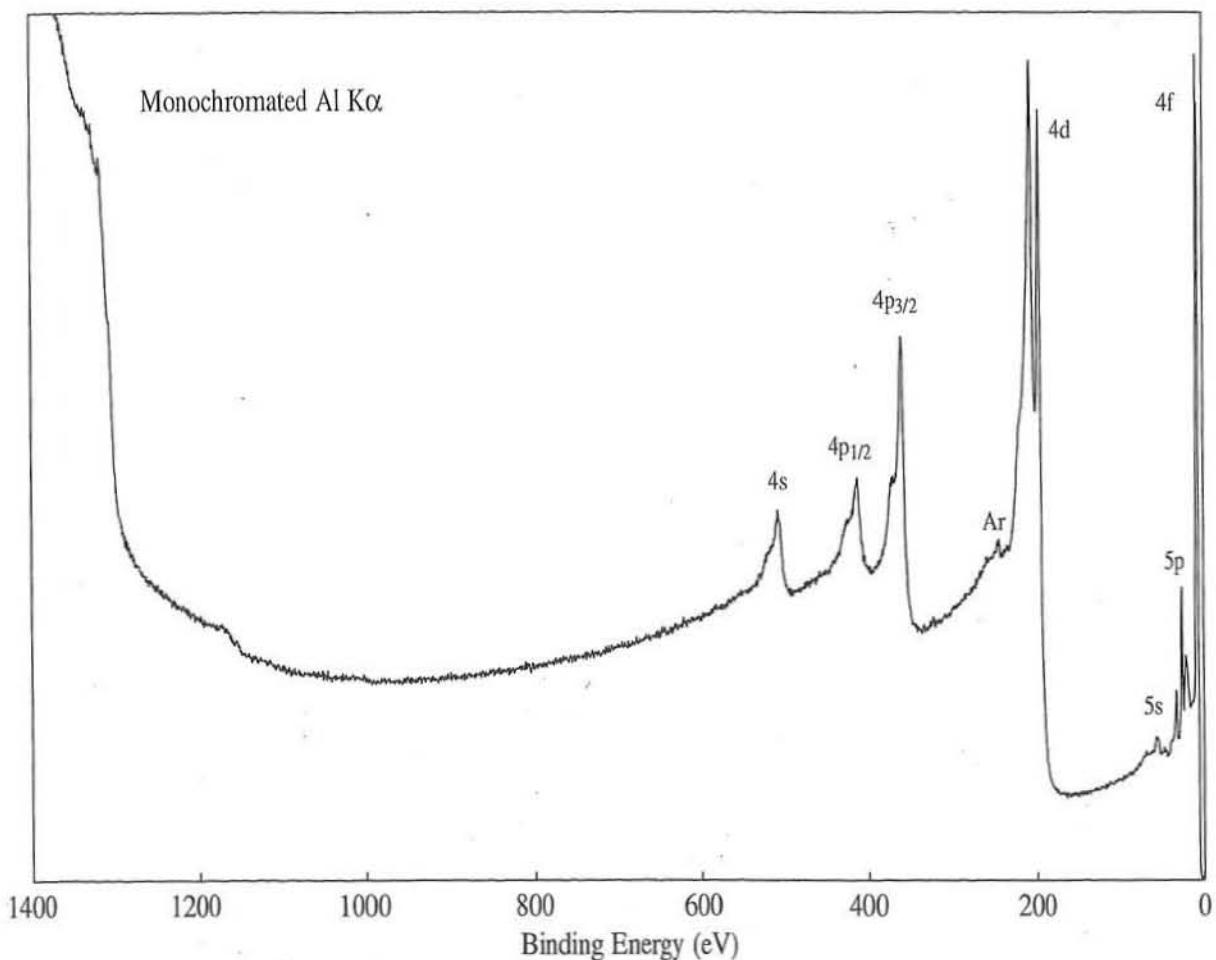
Photoelectron Lines

4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d	5s	5p <sub>1/2</sub>	5p <sub>3/2</sub>	4f
482	389	341	182	51	30	24	3



Compound Type	4d Binding Energy (eV)					
	181	182	183	184	185	186
Yb						
Yb <sub>2</sub> O <sub>3</sub>			■		■	



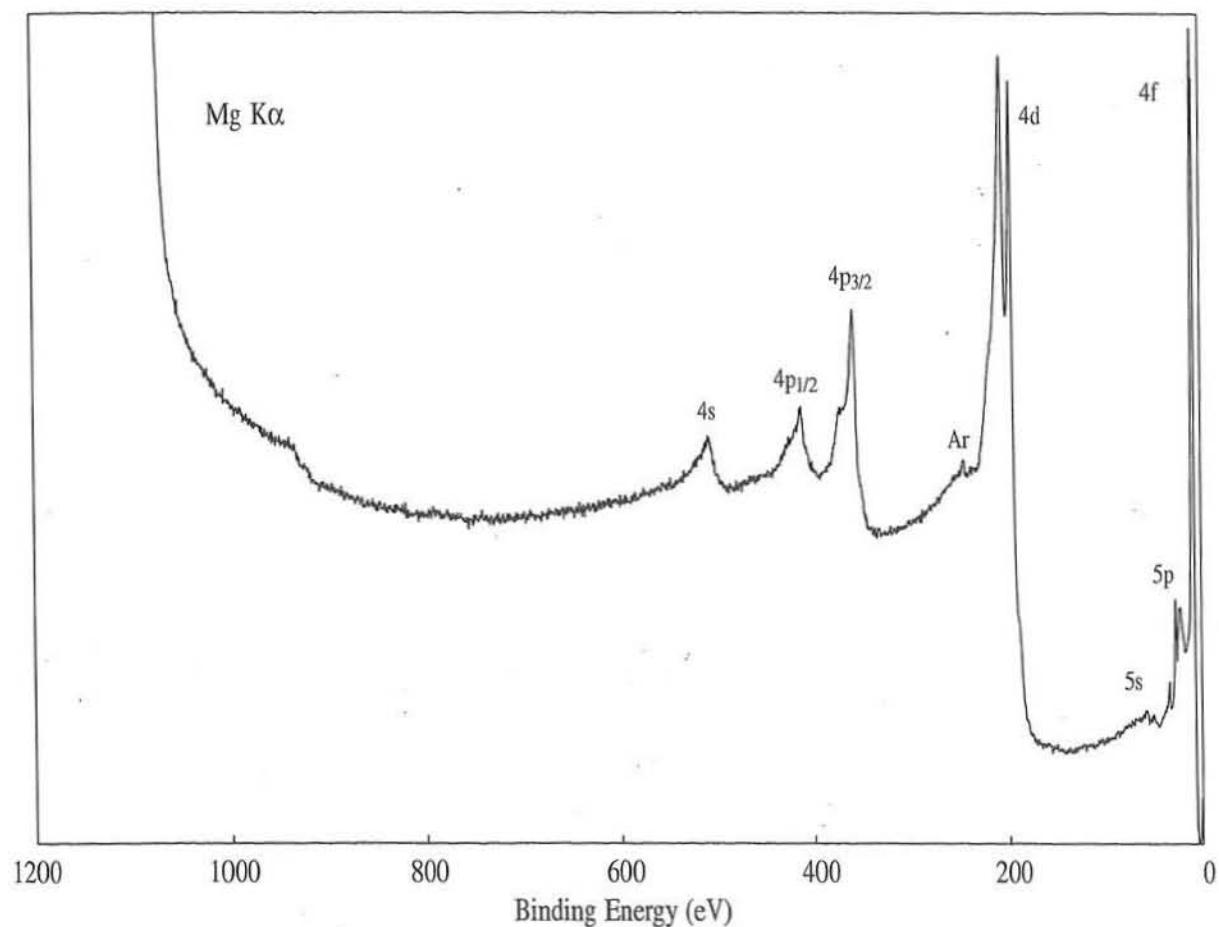


Line Positions (eV)

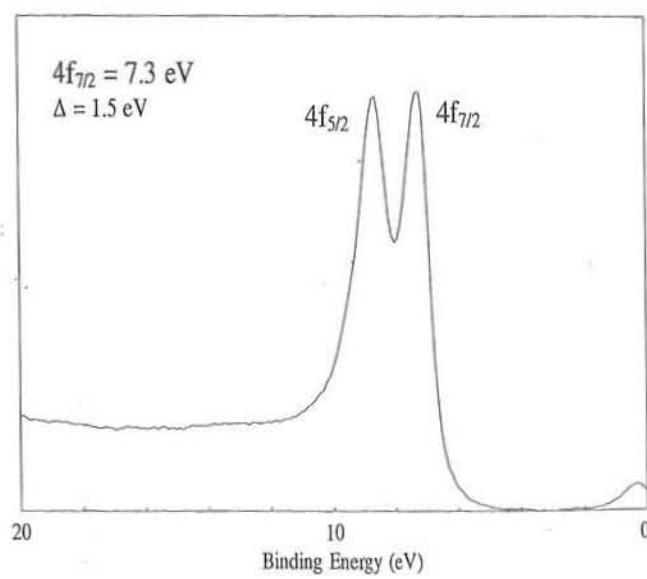
Photoelectron Lines

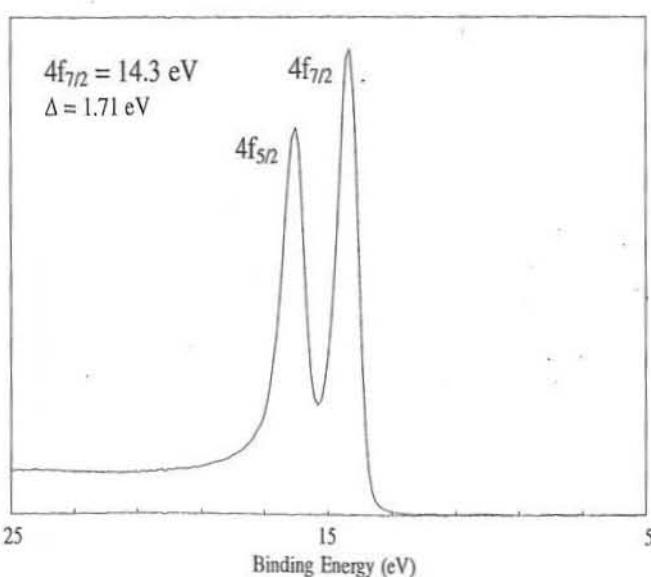
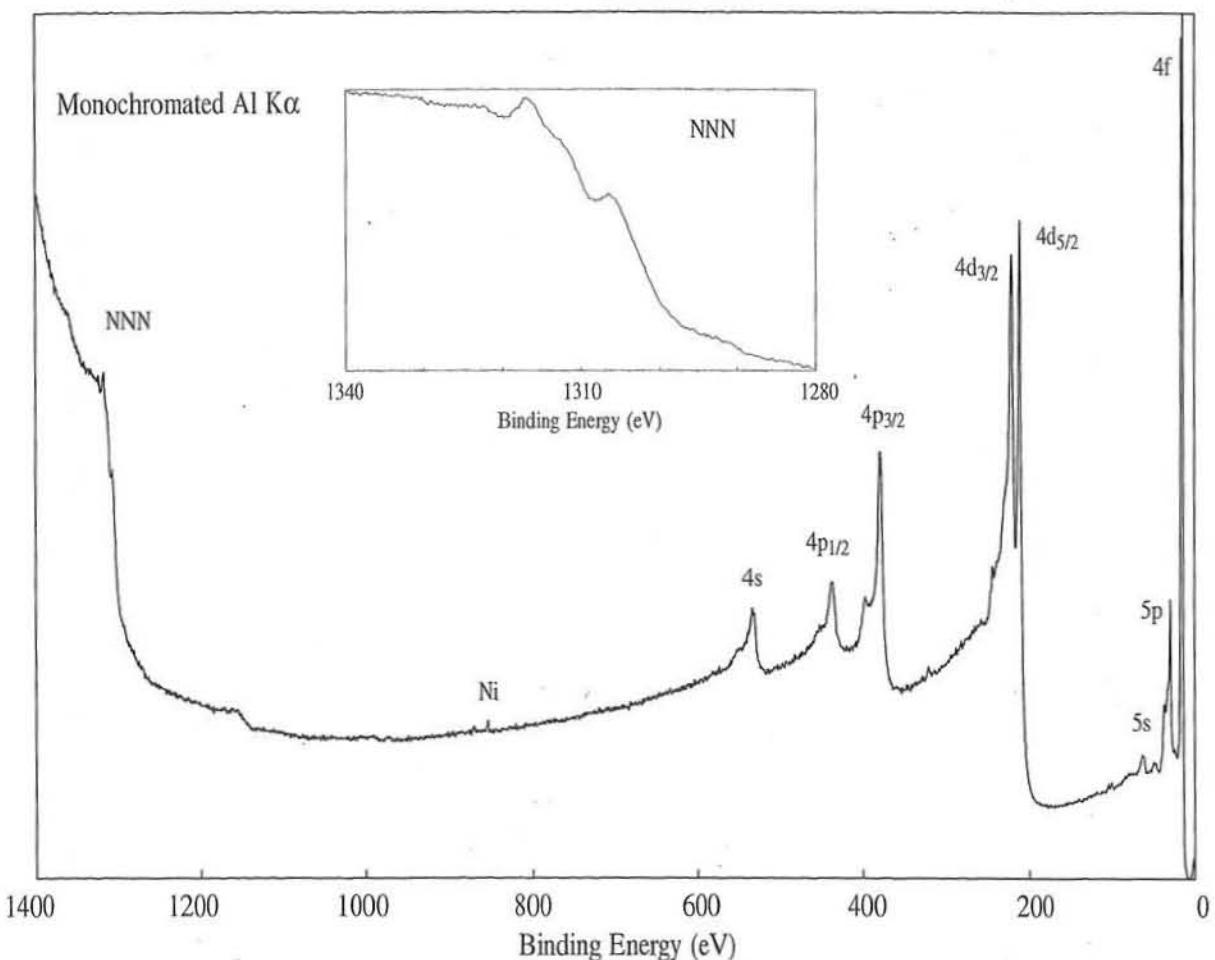
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4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>
509	413	360	206	196
5s	5p <sub>1/2</sub>	5p <sub>3/2</sub>	4f <sub>5/2</sub>	4f <sub>7/2</sub>
57	34	27	9	7



Compound Type	4f $_{7/2}$ Binding Energy (eV)				
	5	6	7	8	9
Lu				■	





Line Positions (eV)

---

Photoelectron Lines

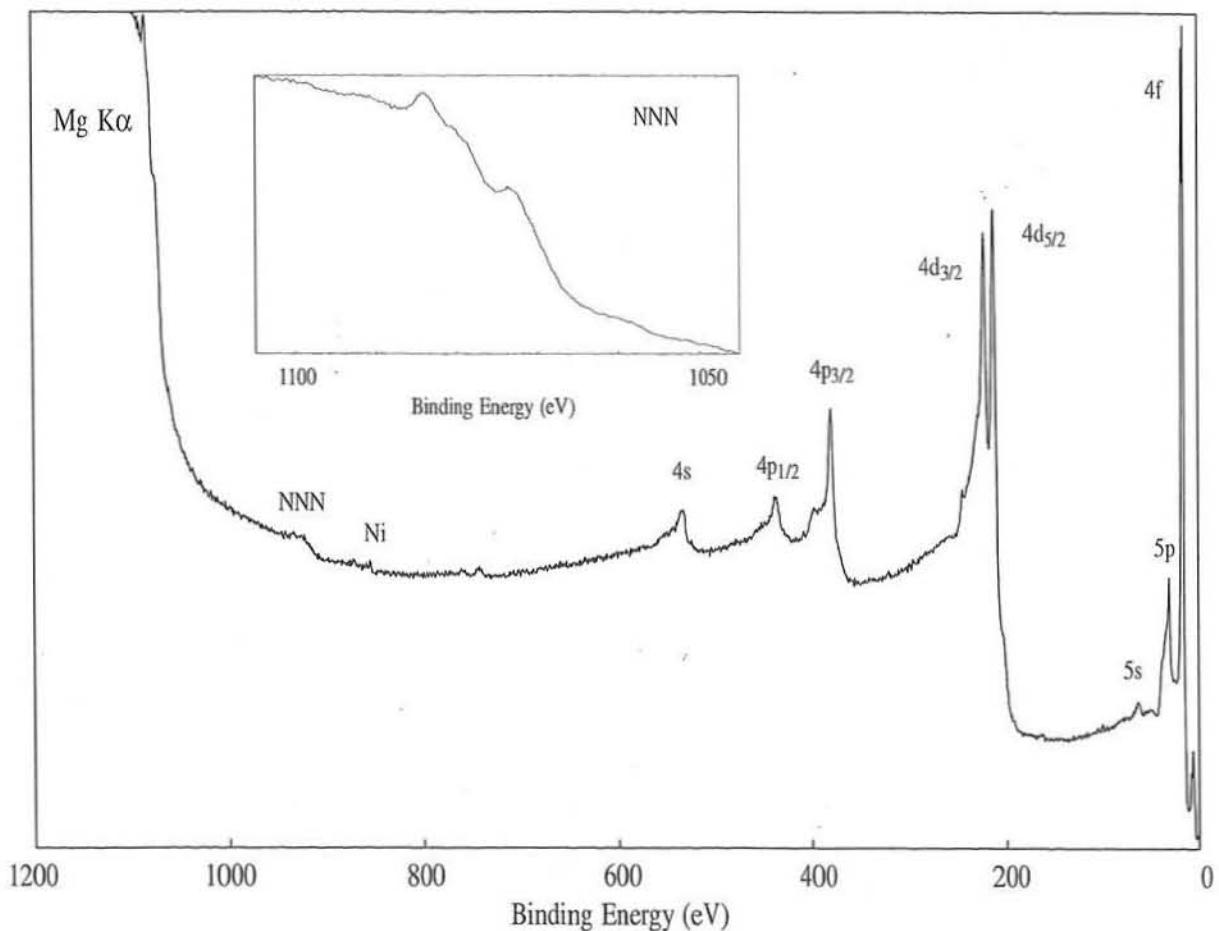
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>
534	437	380	222	211

---

Auger Lines

$N_5N_{67}N_7$	$N_4N_{67}N_7$
1317	1306 (Al)
1084	1073 (Mg)

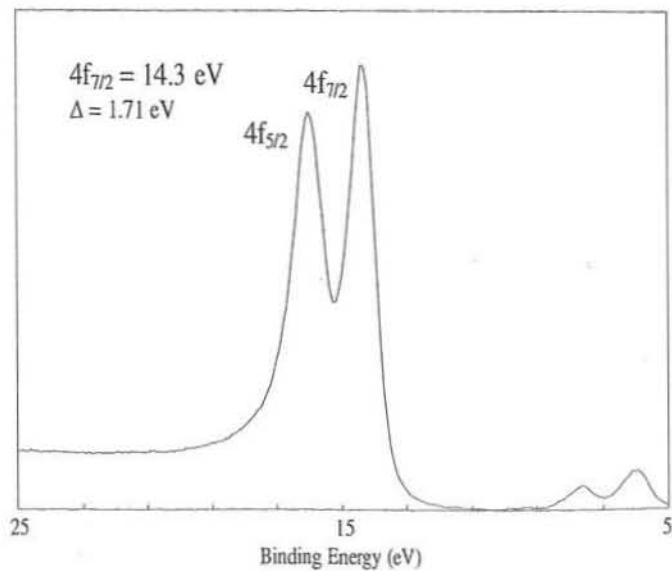
Detailed description: This table provides energy values for various XPS and Auger electron transitions. The photoelectron lines listed are 4s, 4p<sub>1/2</sub>, 4p<sub>3/2</sub>, 4d<sub>3/2</sub>, and 4d<sub>5/2</sub>. The Auger lines listed are  $N_5N_{67}N_7$  at 1317 eV and  $N_4N_{67}N_7$  at 1306 eV (Al), along with 1073 eV (Mg).

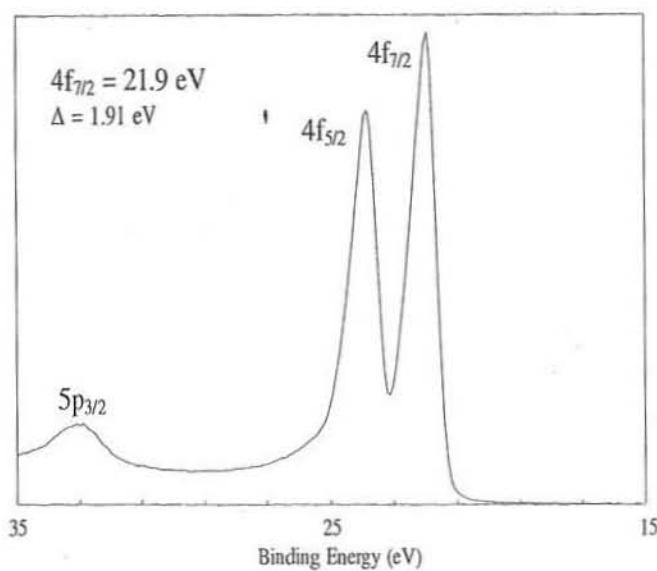
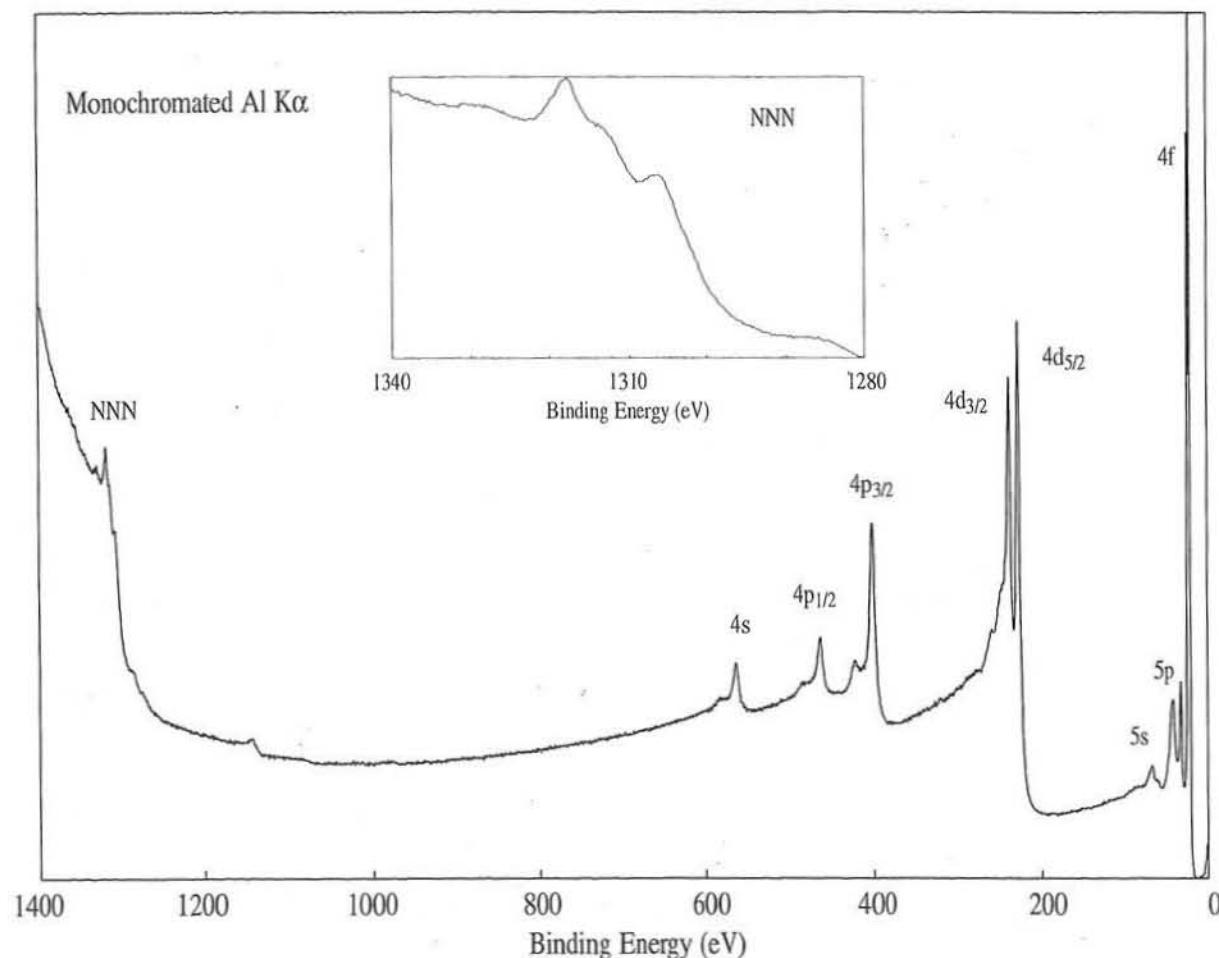


4f <sub>7/2</sub> Binding Energy (eV)			
Compound Type	14	15	16
Hf			
HfO <sub>2</sub>			

4d <sub>5/2</sub> Binding Energy (eV)			
Compound Type	212	213	214
Hf			
HfO <sub>2</sub>			





Line Positions (eV)

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Photoelectron Lines

4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>
563	463	401	238	226

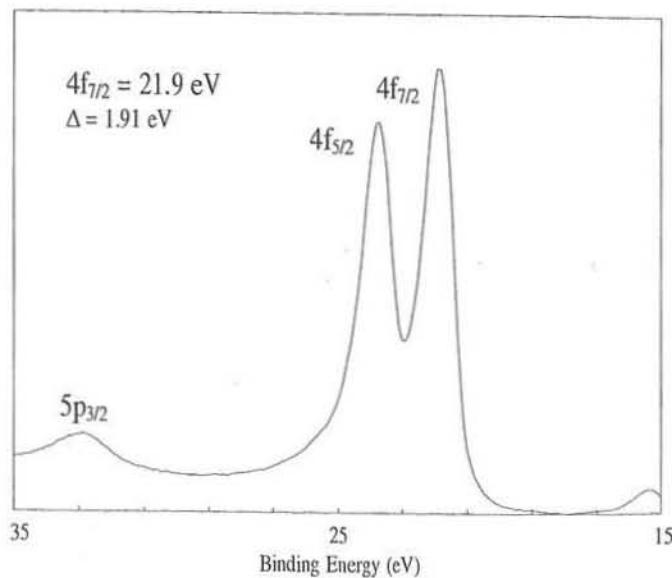
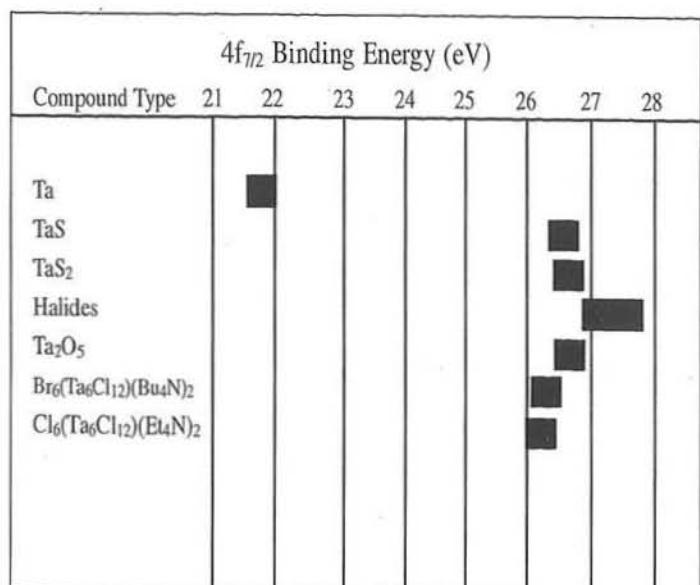
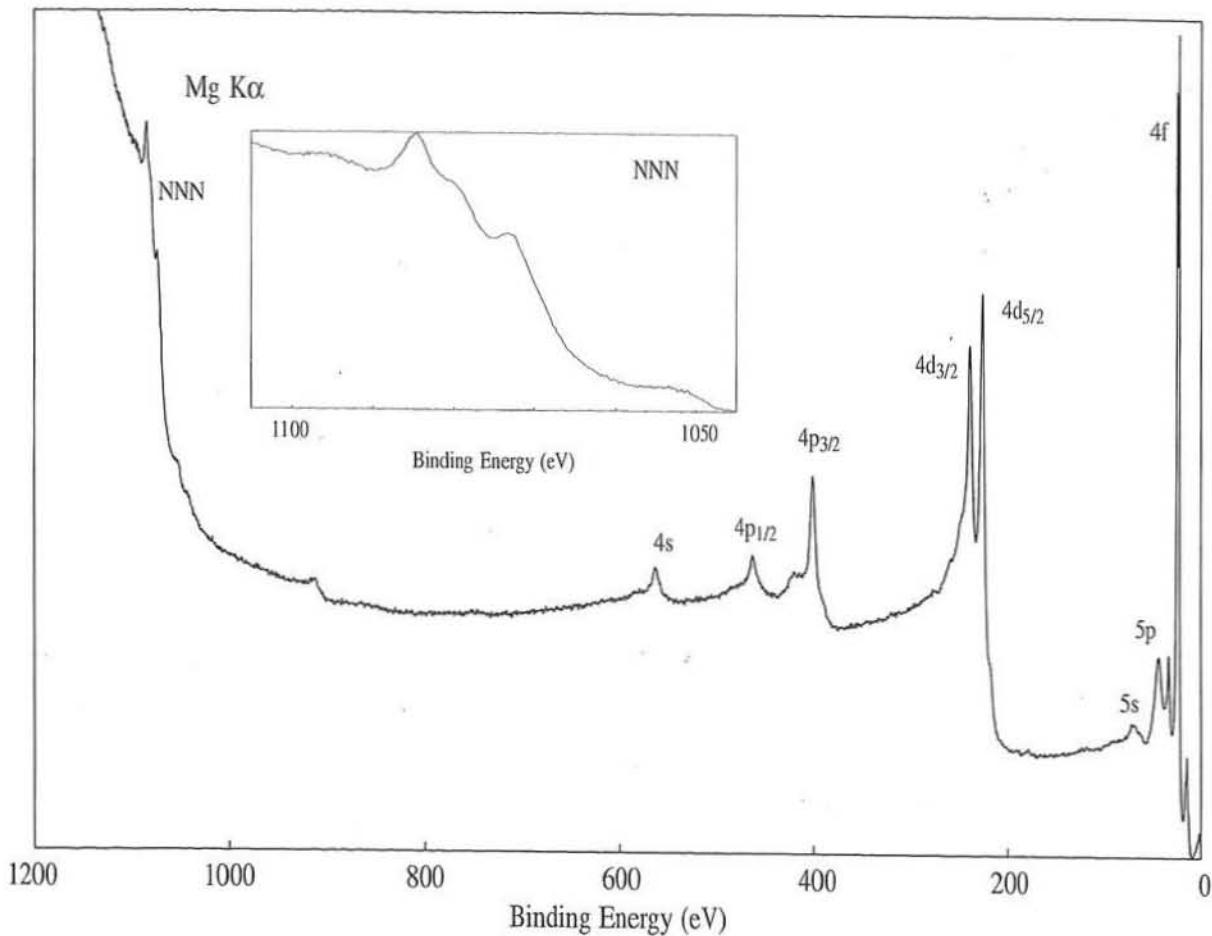
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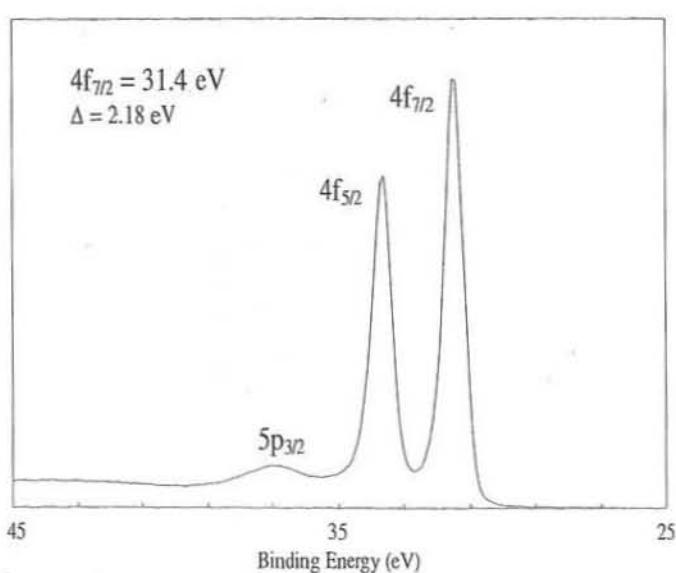
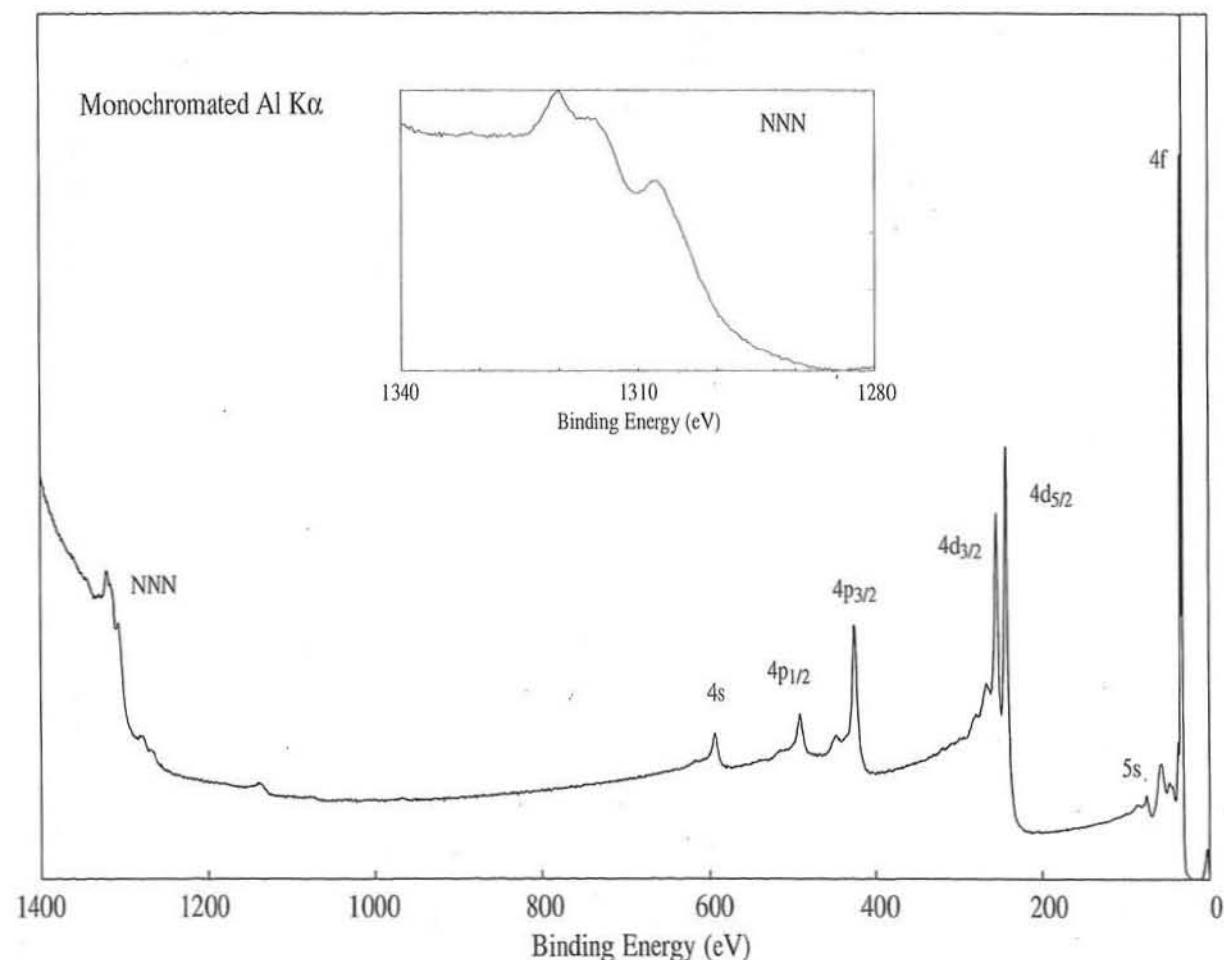
Auger Lines

5s	5p <sub>1/2</sub>	5p <sub>3/2</sub>	4f <sub>5/2</sub>	4f <sub>7/2</sub>
69	43	33	24	22

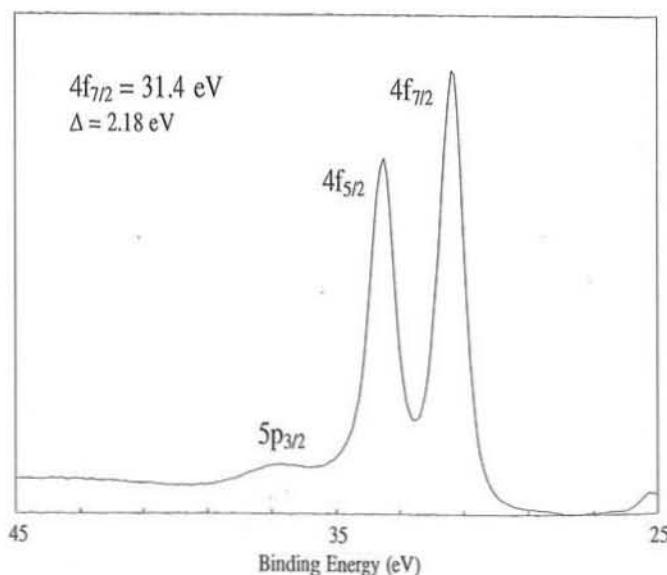
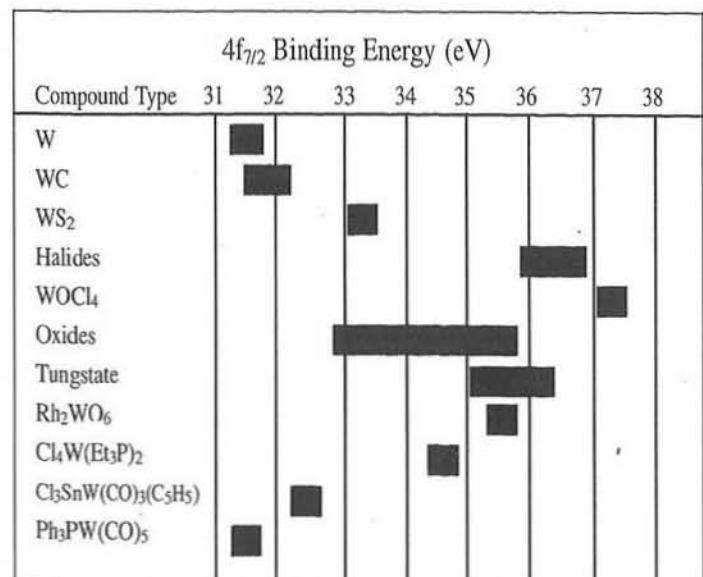
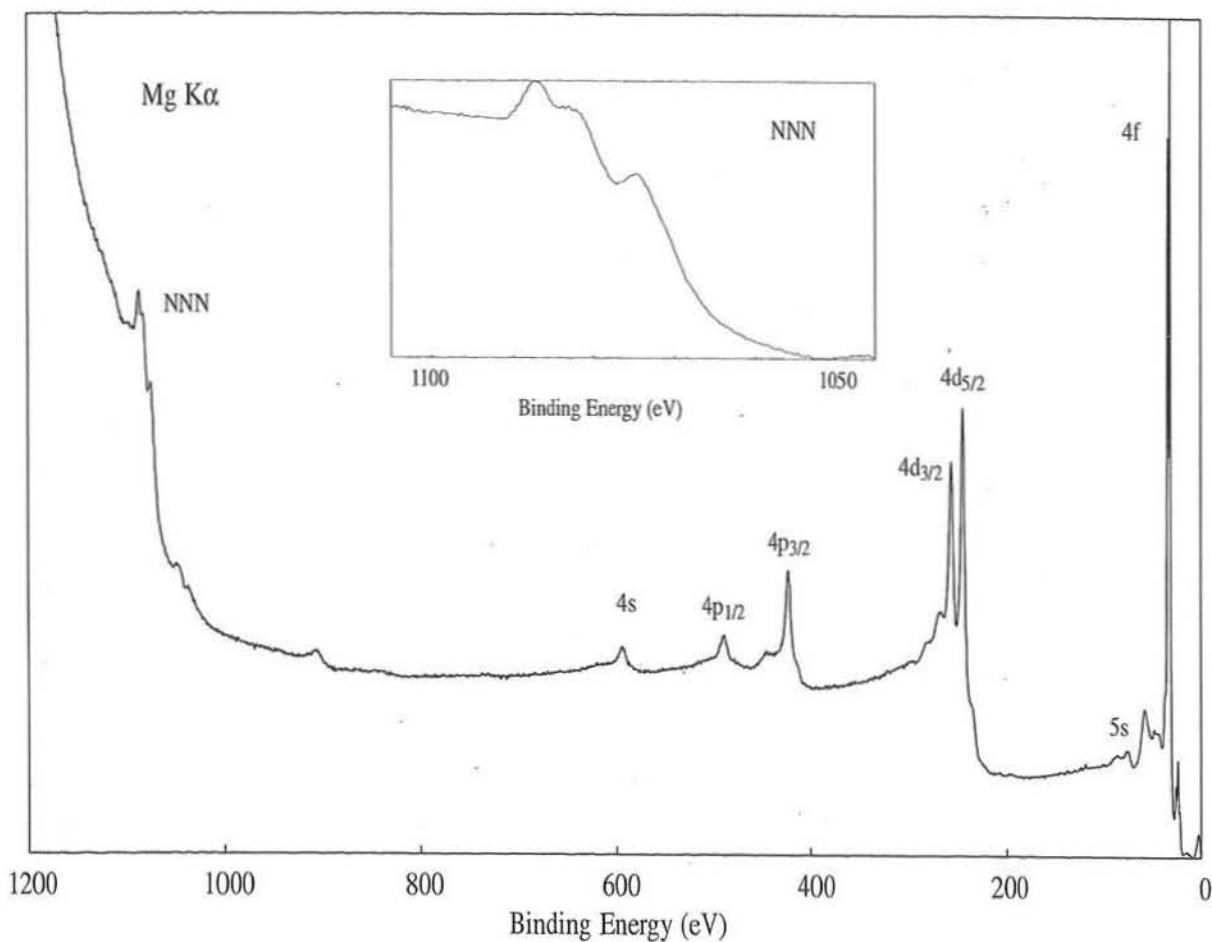
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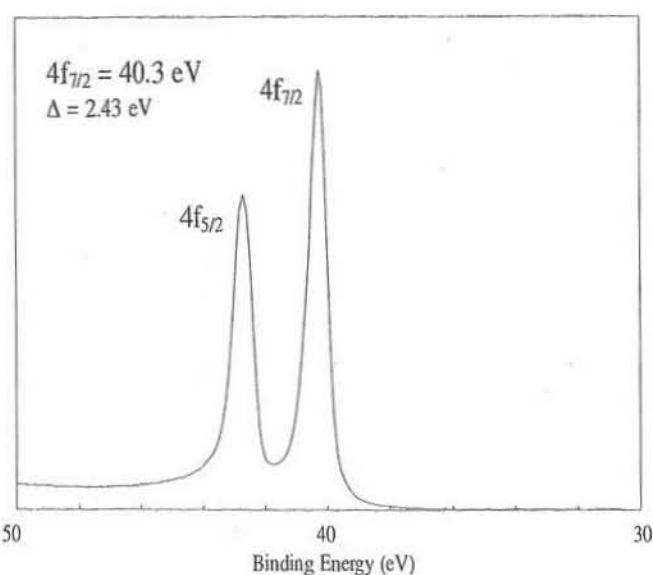
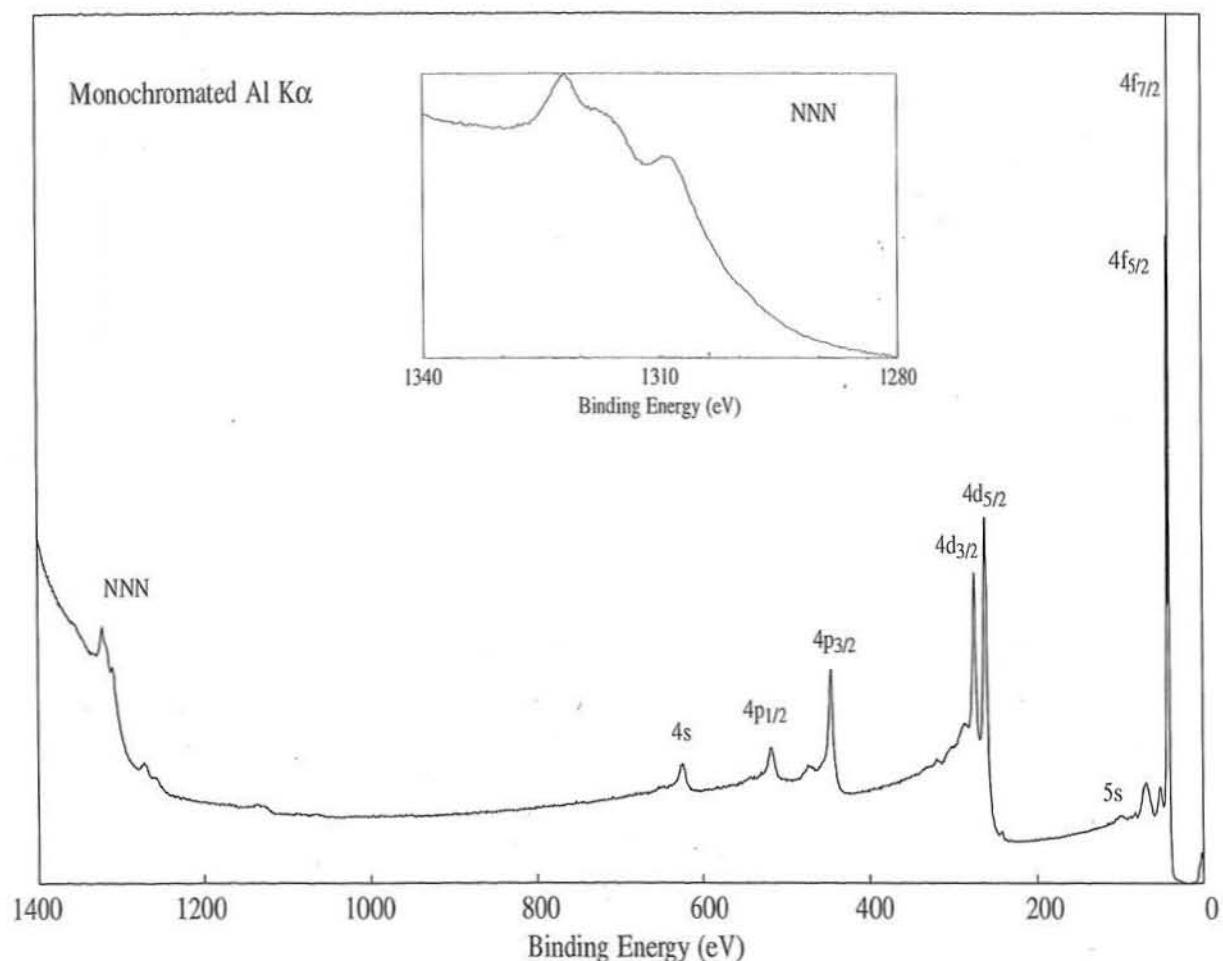
$N_5N_{67}N_7$        $N_4N_{67}N_7$   
1318                  1306 (Al)  
1085                  1073 (Mg)



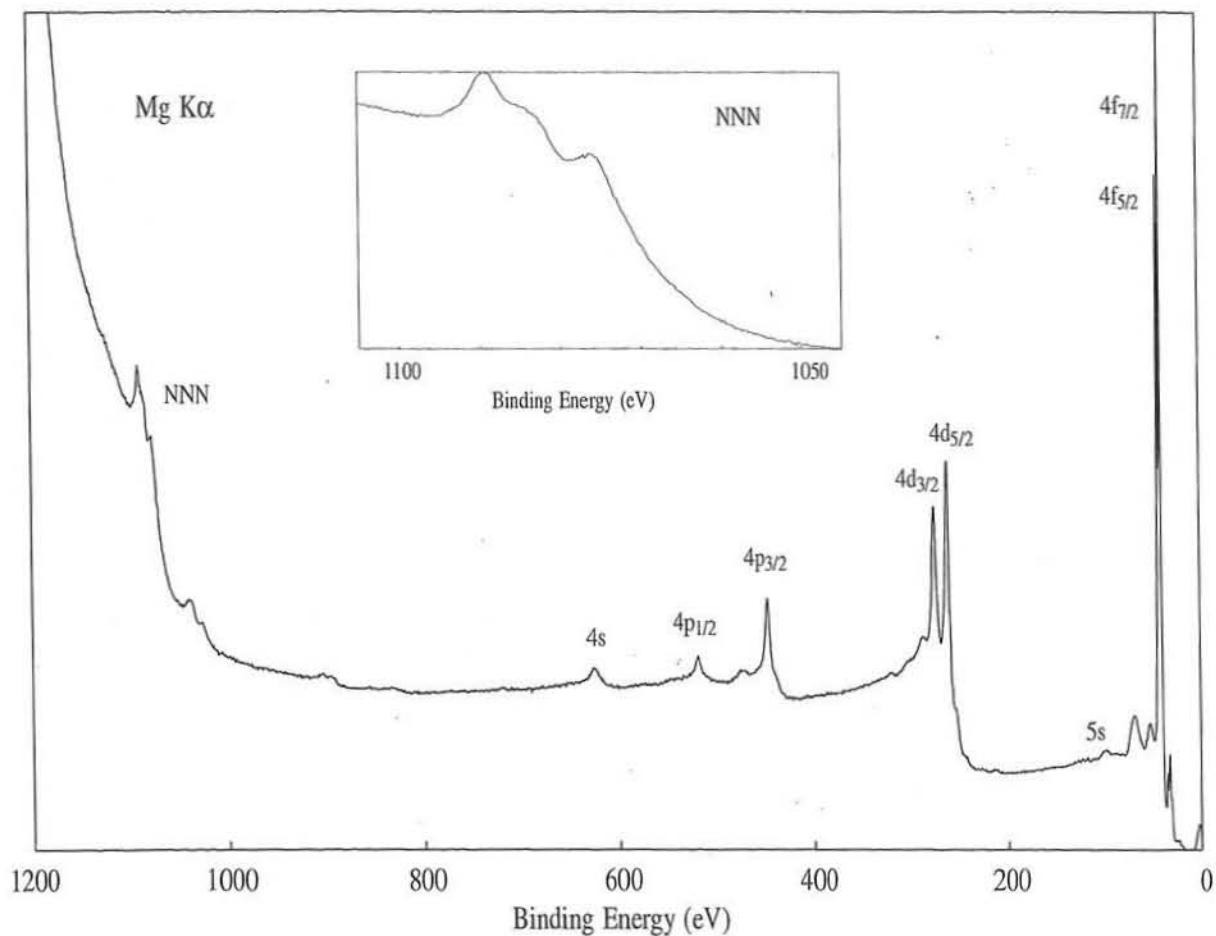


Line Positions (eV)				
Photoelectron Lines				
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>
594	491	424	256	243
Auger Lines				
N <sub>5</sub> N <sub>67</sub> N <sub>7</sub>			N <sub>4</sub> N <sub>67</sub> N <sub>7</sub>	
1320			1307	(Al)
1087			1074	(Mg)

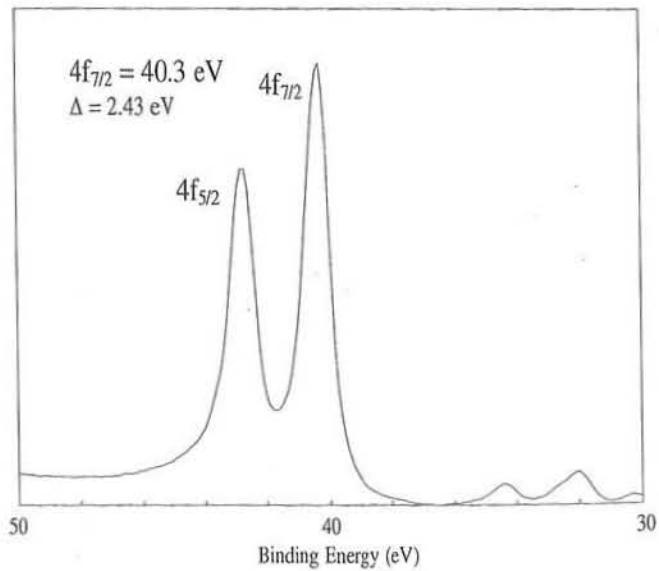


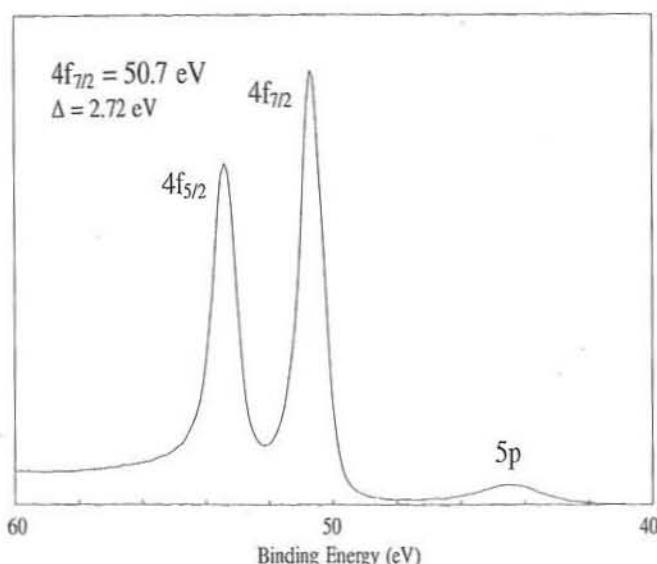
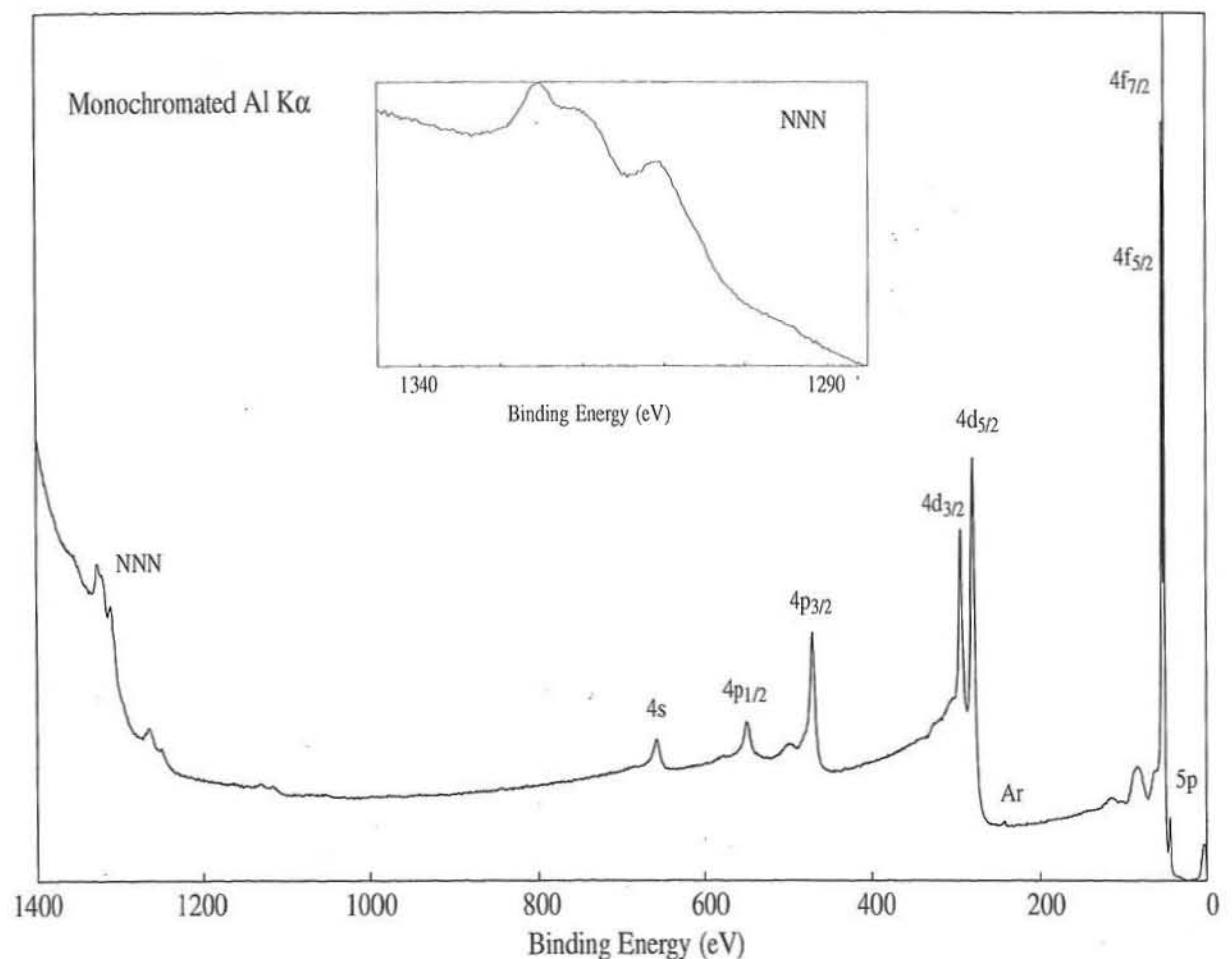


Line Positions (eV)							
Photoelectron Lines							
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>	5s	4f <sub>5/2</sub>	4f <sub>7/2</sub>
625	518	446	274	260	99	42	40
Auger Lines							
N <sub>5</sub> N <sub>6</sub> N <sub>7</sub>			N <sub>4</sub> N <sub>6</sub> N <sub>7</sub>				
1322			1309	(Al)			
1089			1076	(Mg)			



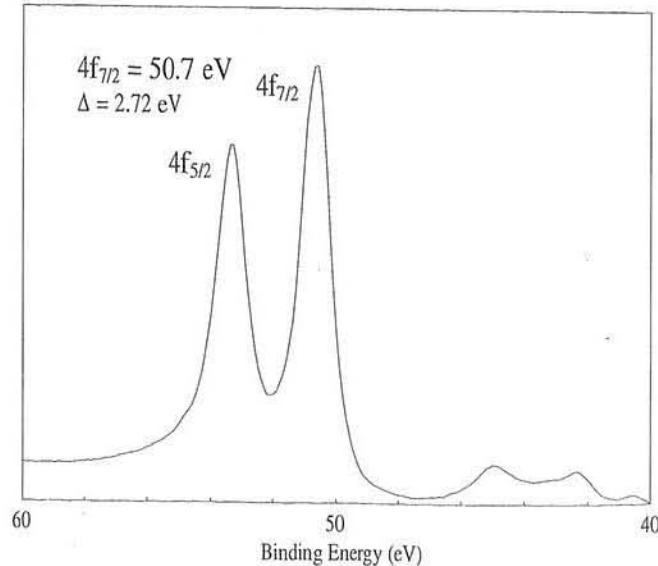
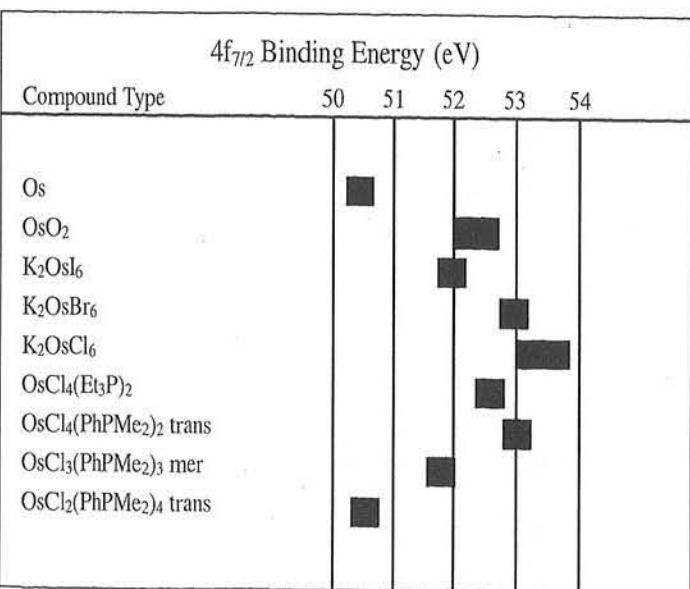
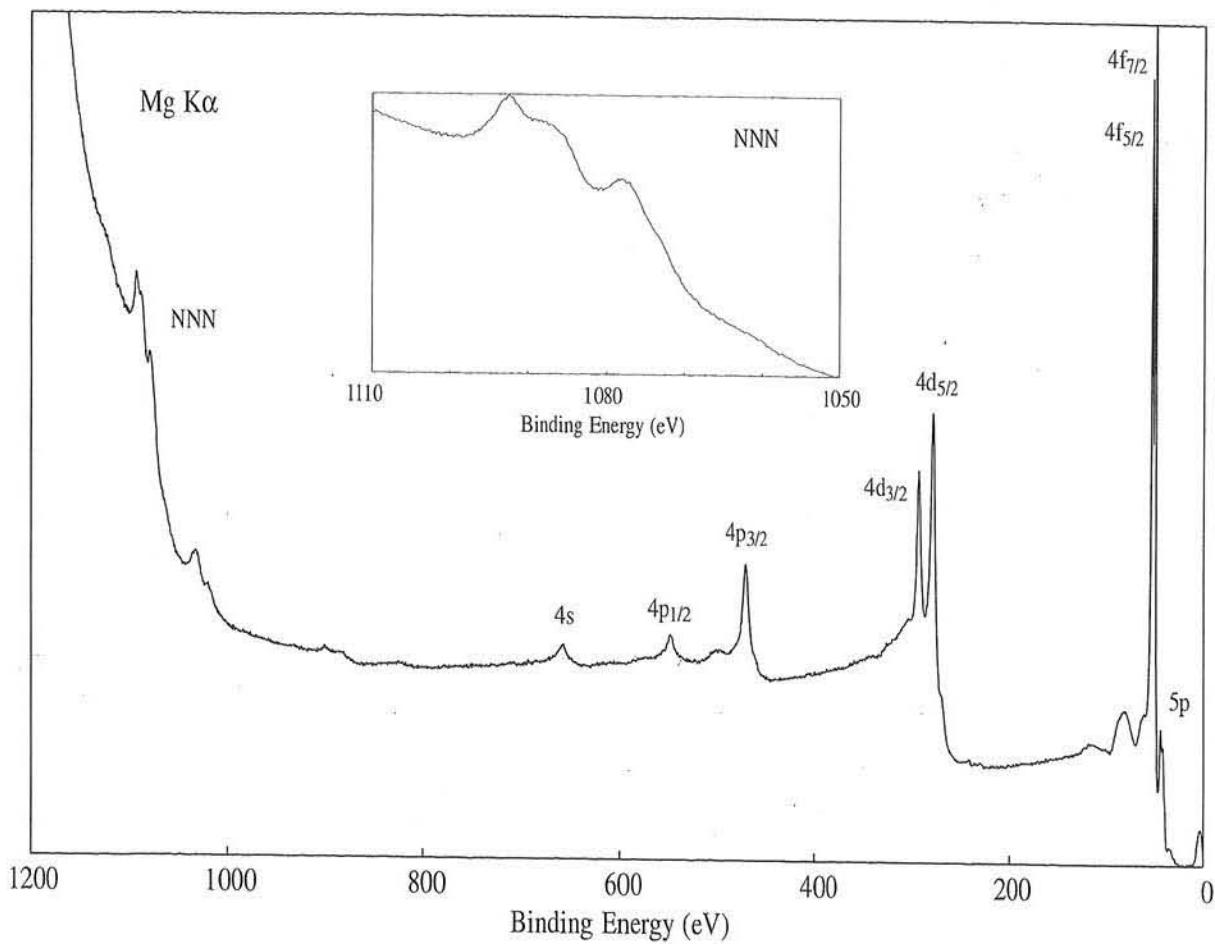
Compound Type	40	41	42	43	44	45	46	47
Re		■					■	
ReO <sub>2</sub>								
ReO <sub>3</sub>								
K <sub>2</sub> ReCl <sub>6</sub>								
Cl <sub>3</sub> ReO(Ph <sub>3</sub> P) <sub>2</sub>								
Cl <sub>2</sub> ReN(Ph <sub>3</sub> P) <sub>2</sub>		■			■			
Cl <sub>4</sub> Re(Et <sub>3</sub> P) <sub>2</sub>			■		■			
Cl <sub>4</sub> Re(PMe <sub>2</sub> Ph) <sub>2</sub>								
Cl <sub>3</sub> Re(PMe <sub>2</sub> Ph) <sub>3</sub> mer								
Cl <sub>2</sub> Re(PMe <sub>2</sub> Ph) <sub>4</sub> trans	■							
ClReN <sub>2</sub> (PMe <sub>2</sub> Ph) <sub>4</sub> trans		■						

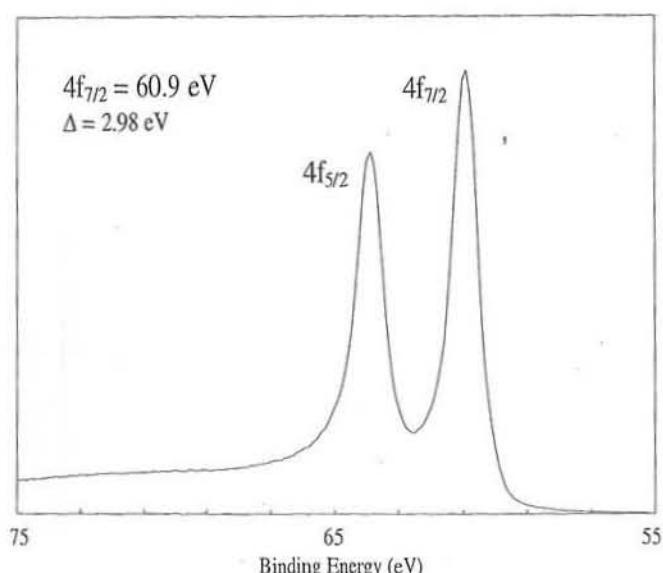
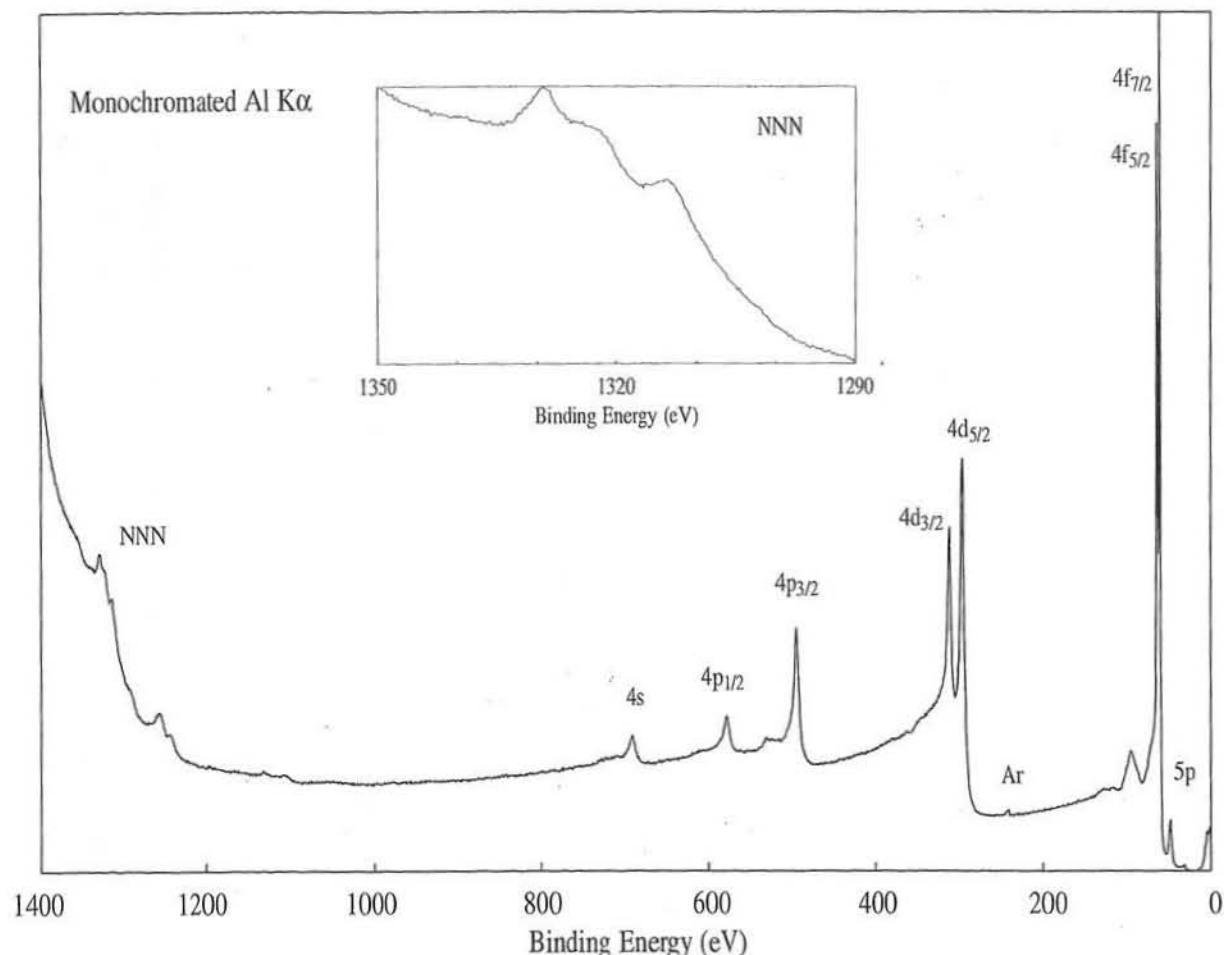




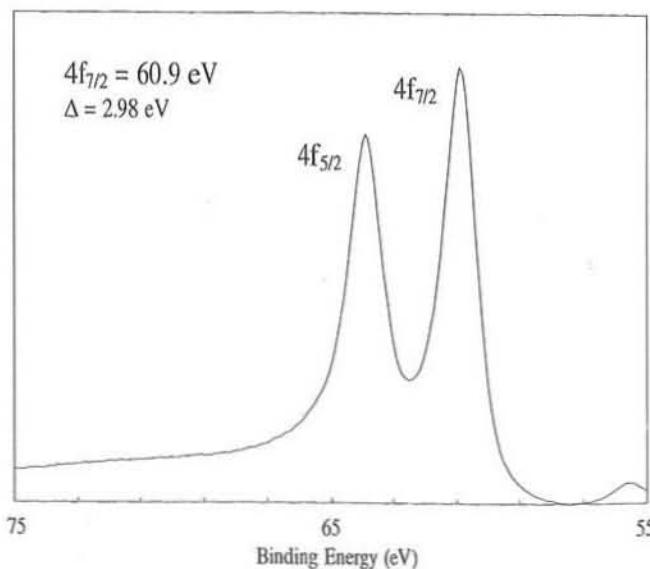
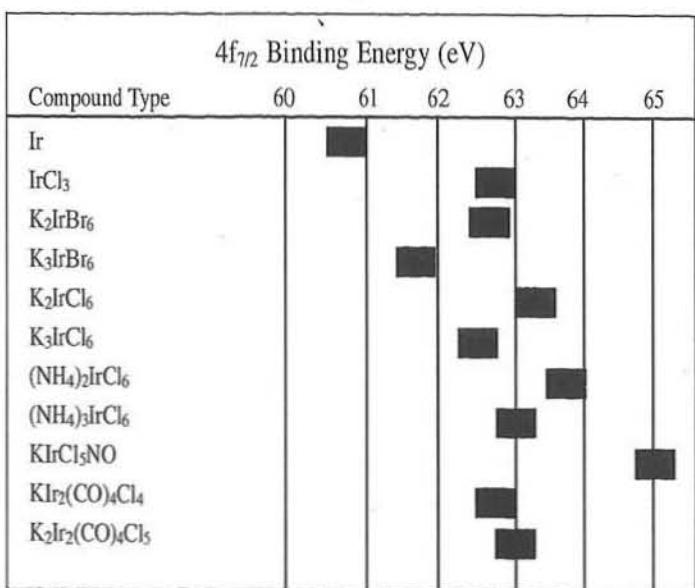
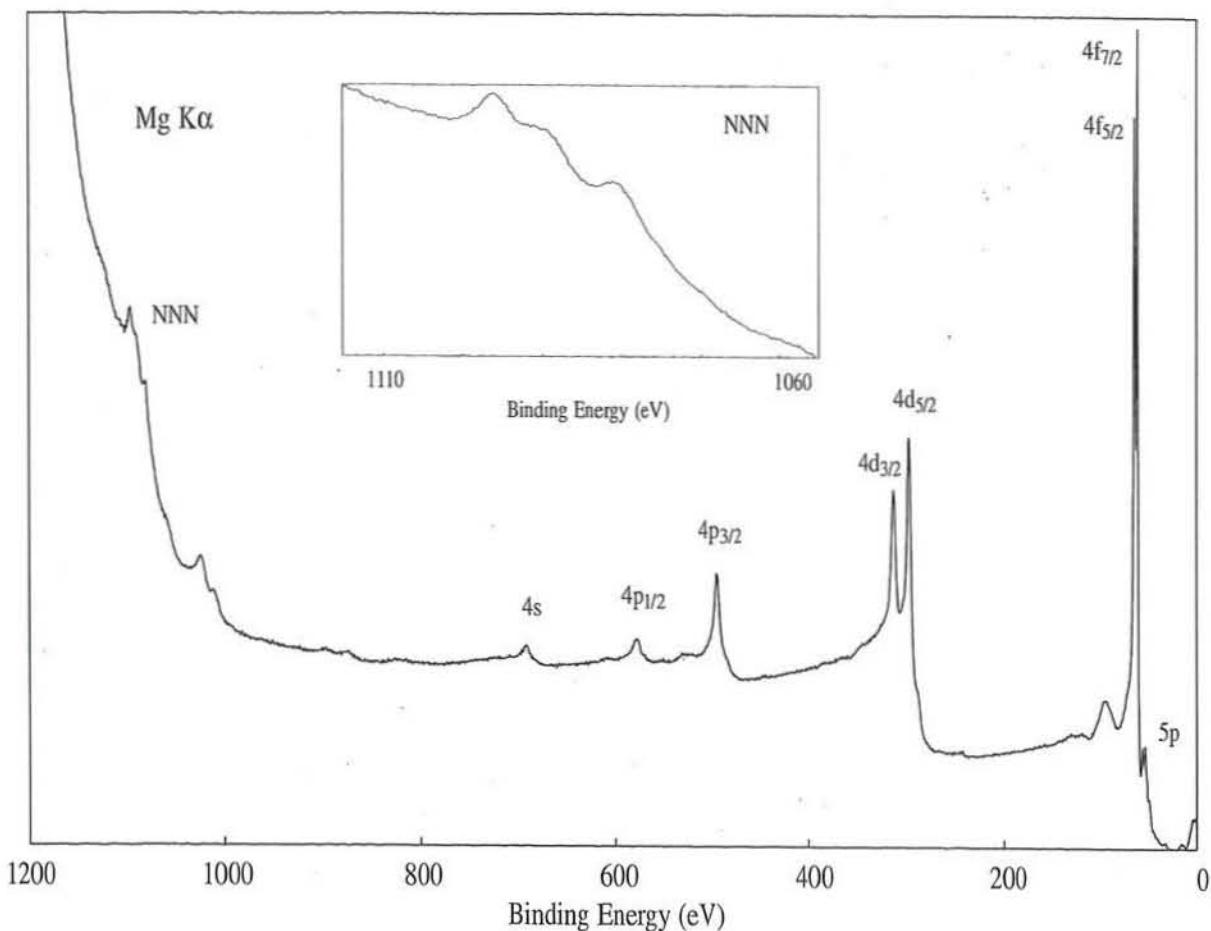
Line Positions (eV)				
Photoelectron Lines				
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>
658	548	471	293	279
5s*	4f <sub>5/2</sub>	4f <sub>7/2</sub>	5p	
89	54	51	44	
Auger Lines				
$\text{N}_5\text{N}_{67}\text{N}_7$		$\text{N}_4\text{N}_{67}\text{N}_7$		
1326		1311 (Al)		
1093		1078 (Mg)		

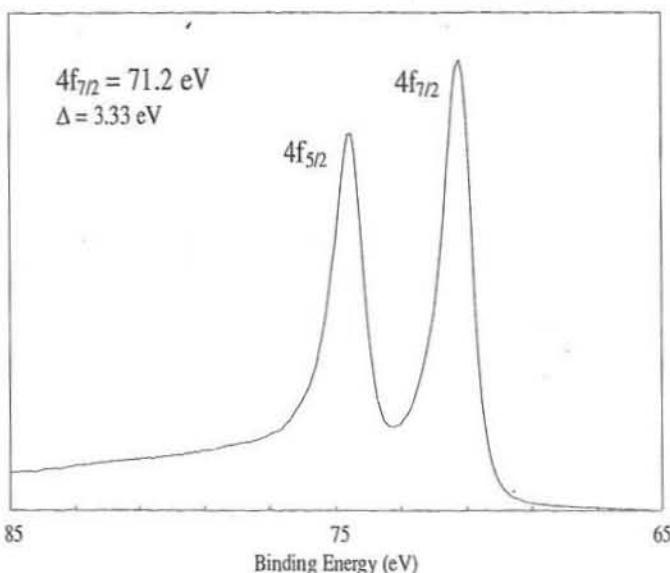
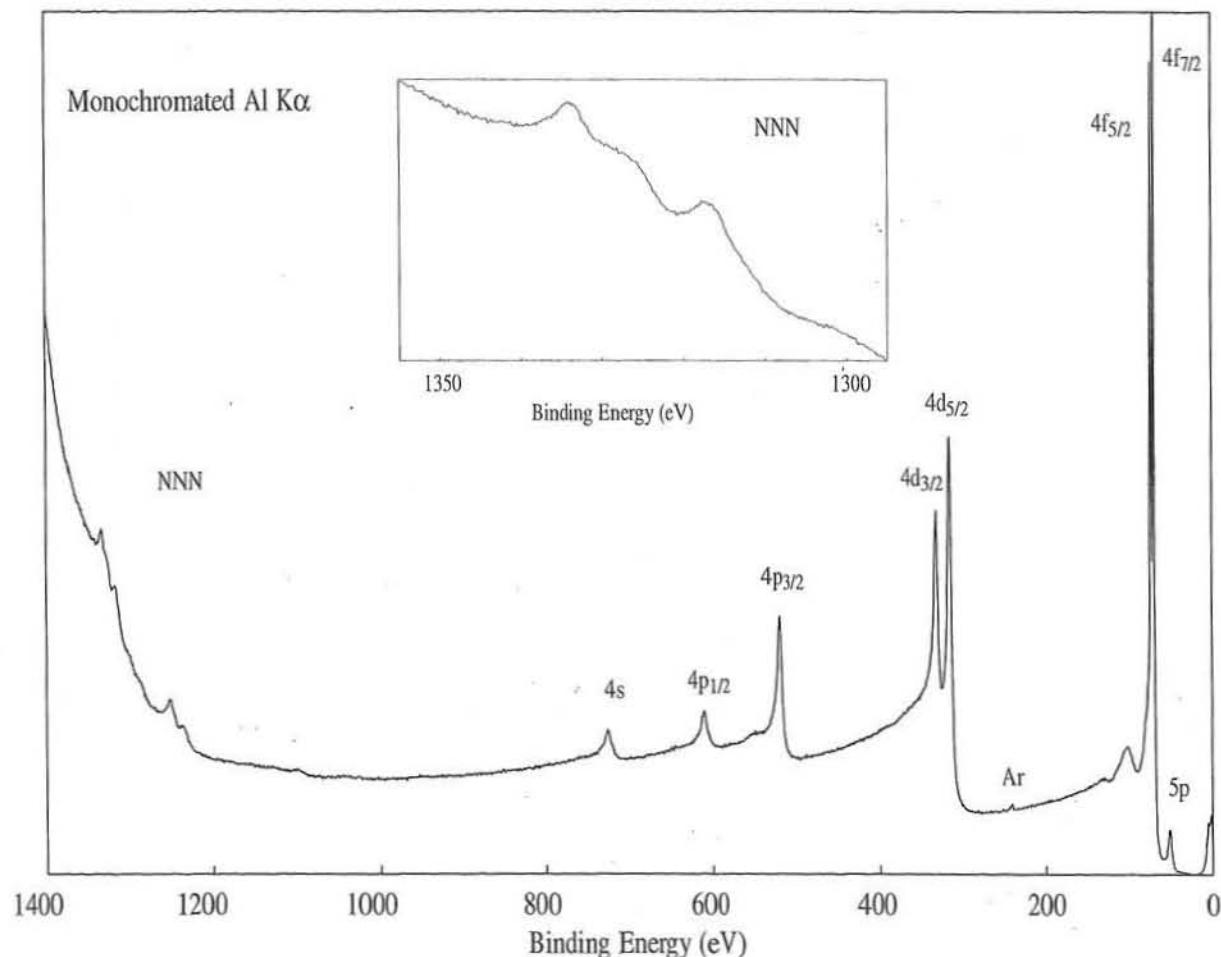
\*Estimate





Line Positions (eV)				
Photoelectron Lines				
4s	4p $_{1/2}$	4p $_{3/2}$	4d $_{3/2}$	4d $_{5/2}$
692	578	495	312	297
Auger Lines				
N <sub>5</sub> N <sub>67</sub> N <sub>7</sub>		N <sub>4</sub> N <sub>67</sub> N <sub>7</sub>		
1329		1314	(Al)	
1096		1081	(Mg)	
*Estimate				





Line Positions (eV)

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Photoelectron Lines

4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>
725	609	520	332	315

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Auger Lines

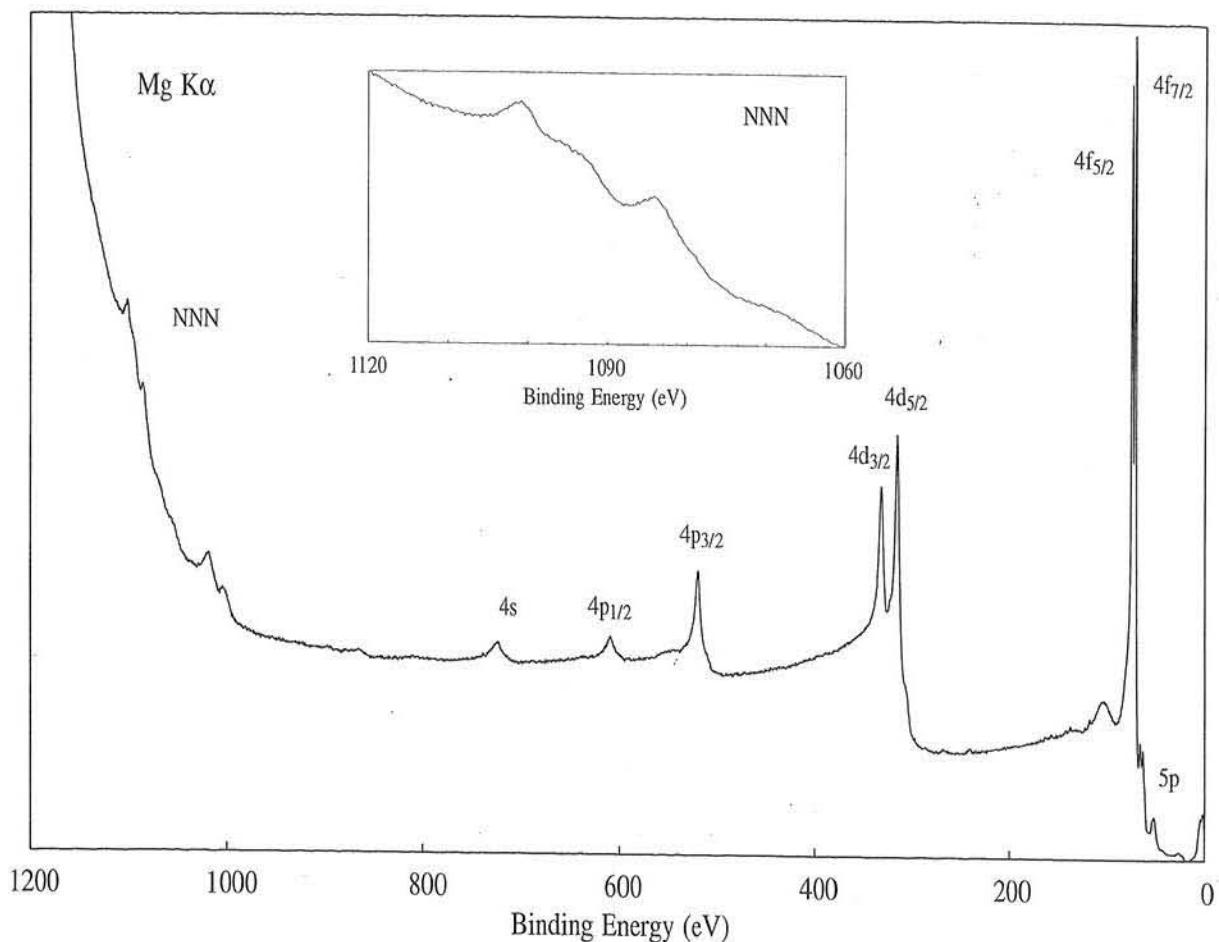
5s*	4f <sub>5/2</sub>	4f <sub>7/2</sub>	5p
103	74	71	52

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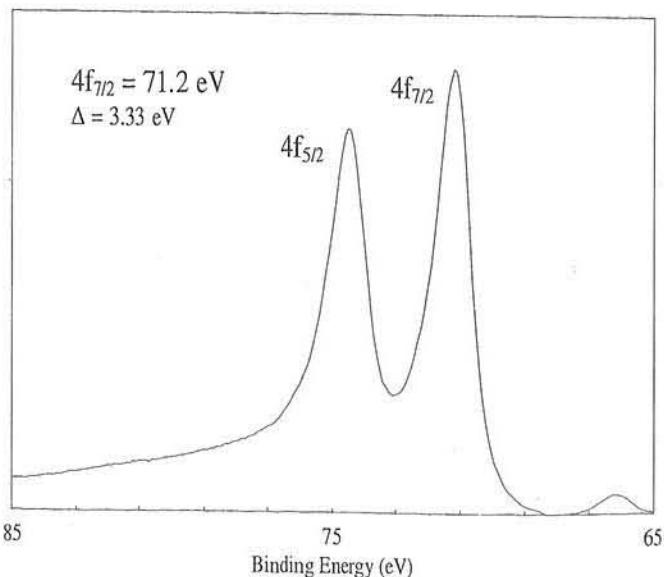
N<sub>5</sub>N<sub>67</sub>N<sub>7</sub>      N<sub>4</sub>N<sub>67</sub>N<sub>7</sub>

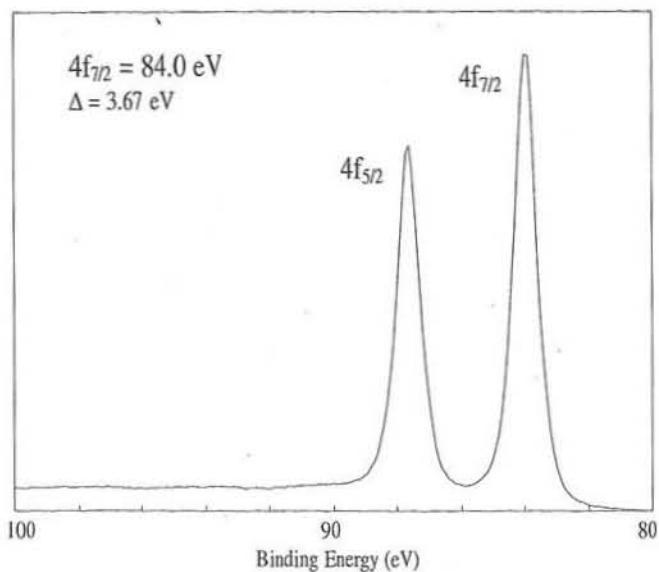
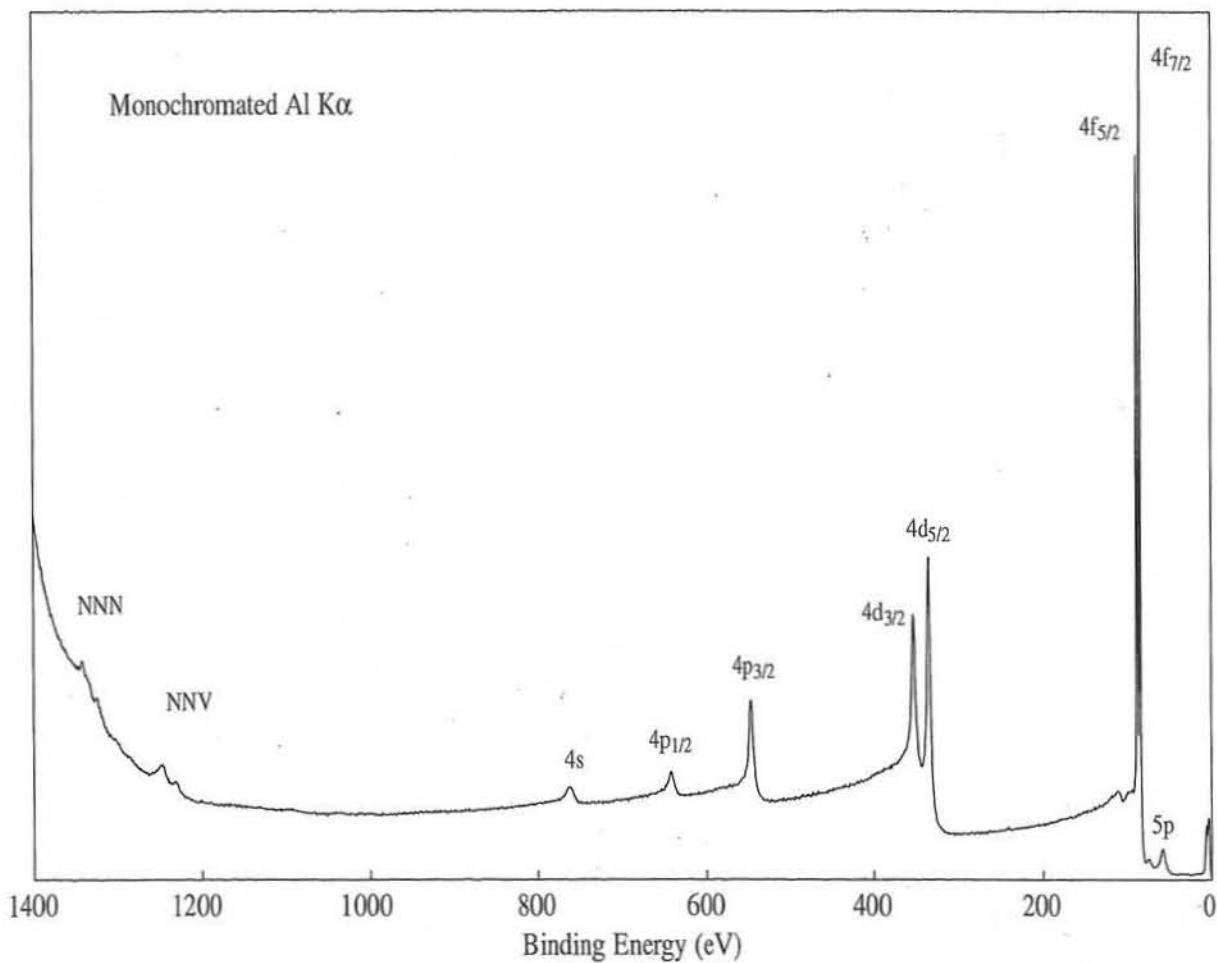
1334      1317 (Al)  
 1101      1084 (Mg)

\*Estimate



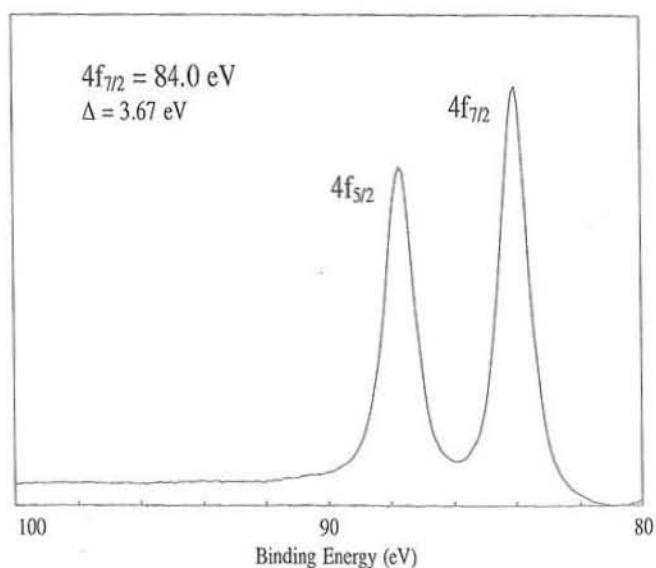
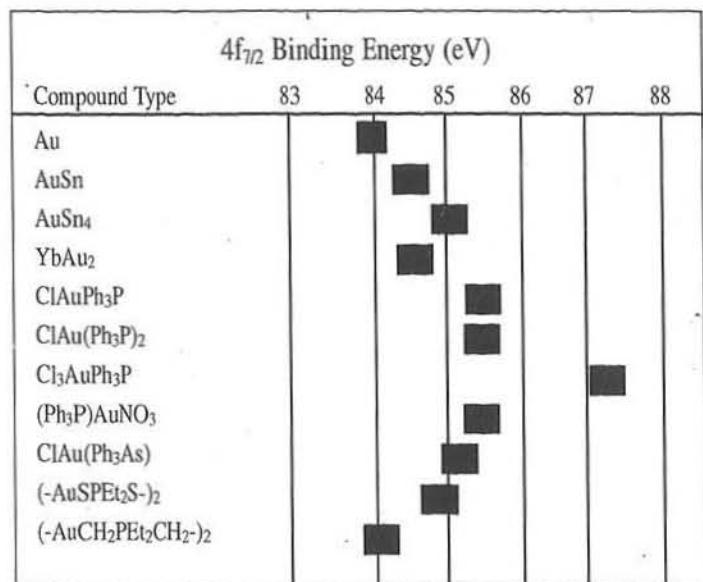
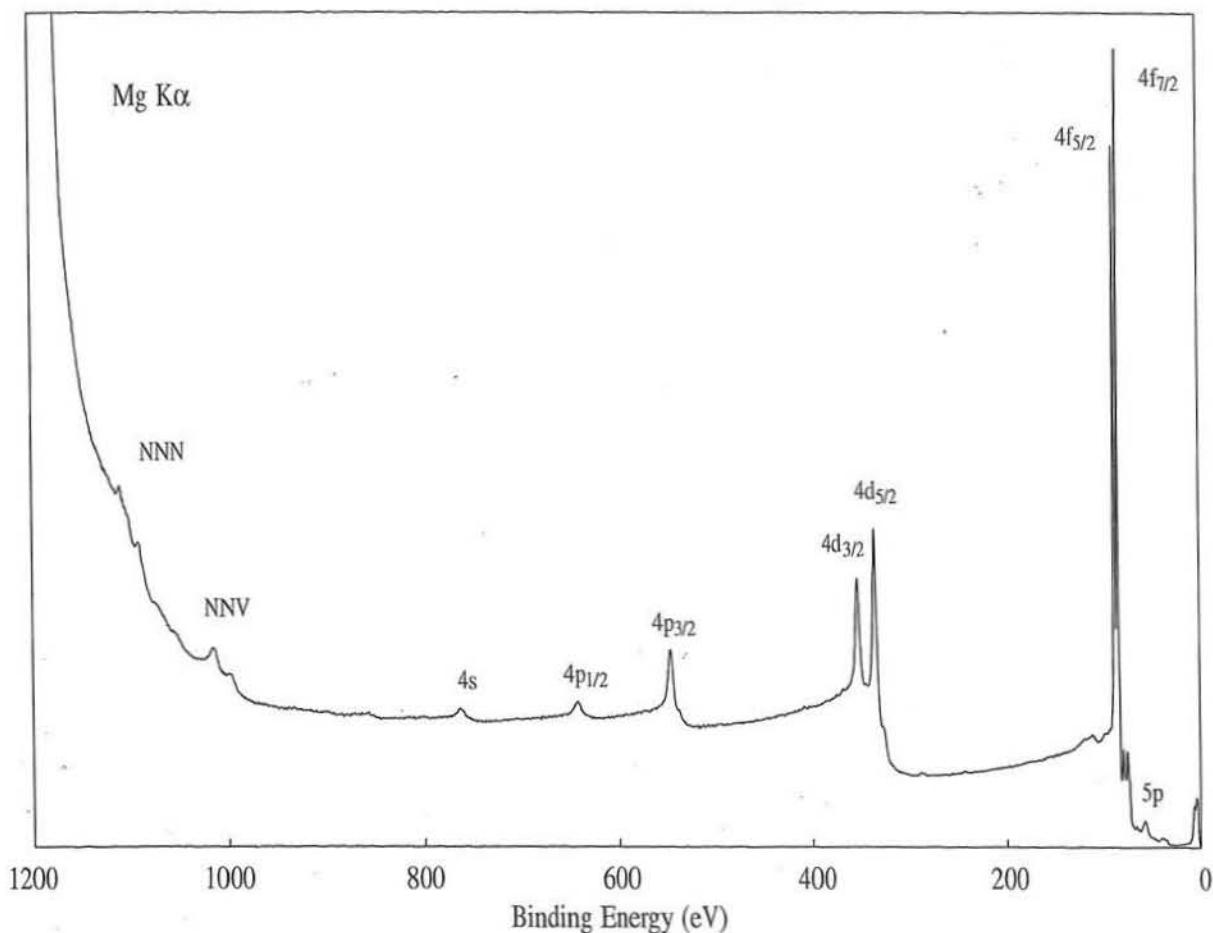
Compound Type	4f $_{7/2}$ Binding Energy (eV)							
	71	72	73	74	75	76	77	78
Pt								
PtSi								
Pt <sub>2</sub> Si								
PtCl <sub>2</sub>								
PtCl <sub>4</sub>								
Oxides								
Pt(OH) <sub>2</sub>								
(IV) Halides								
Cl <sub>2</sub> Pt(Ph <sub>3</sub> P) <sub>2</sub> cis								
I <sub>2</sub> Pt(Me <sub>3</sub> P) <sub>2</sub> cis								
I <sub>2</sub> Pt(Me <sub>3</sub> P) <sub>2</sub> trans								

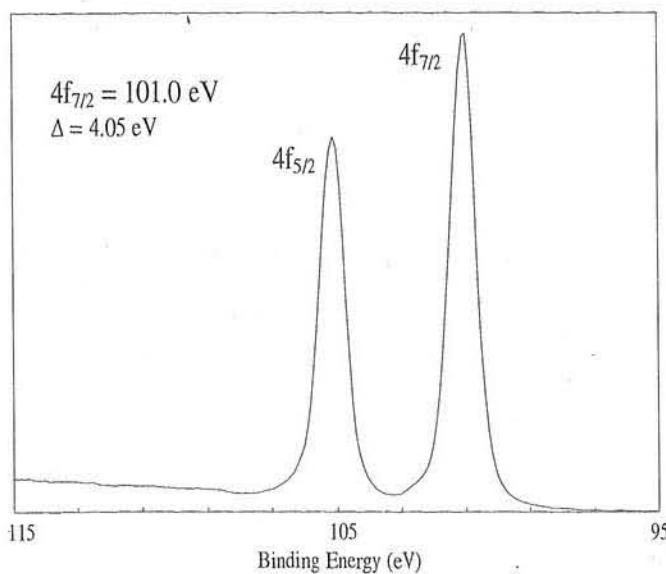
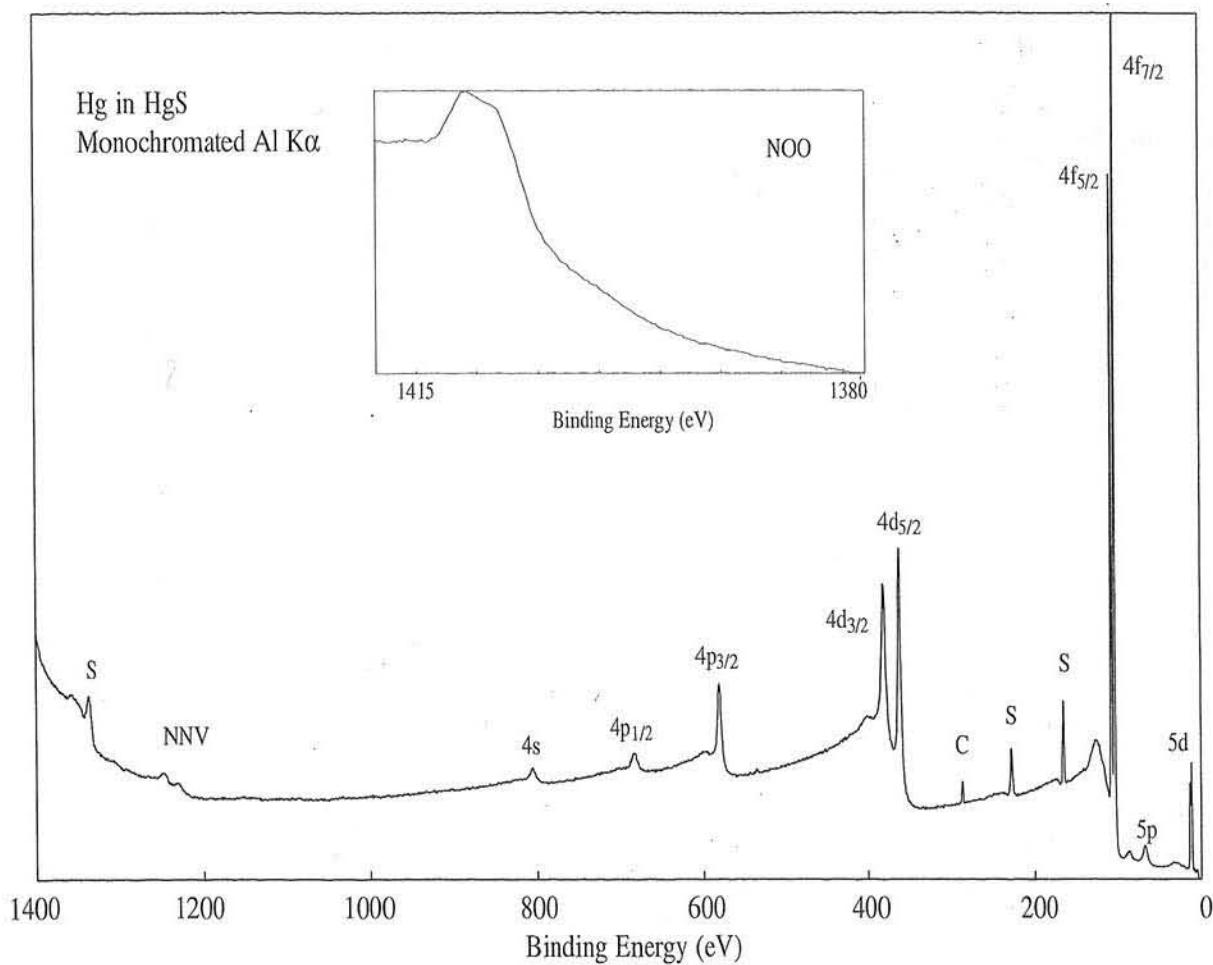


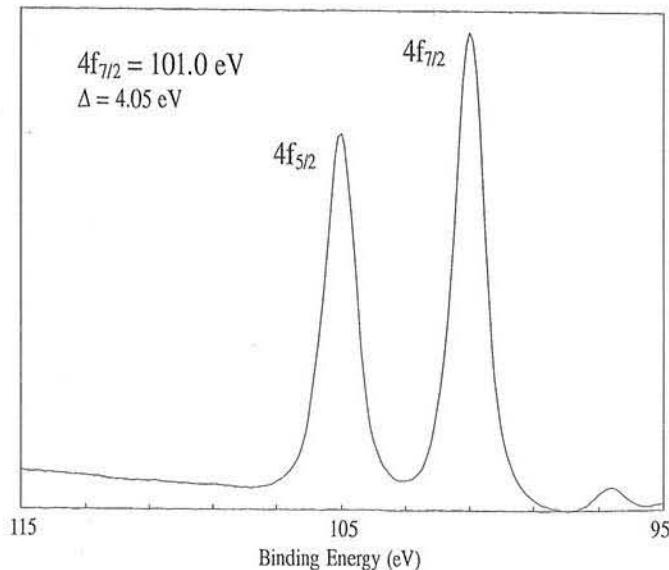
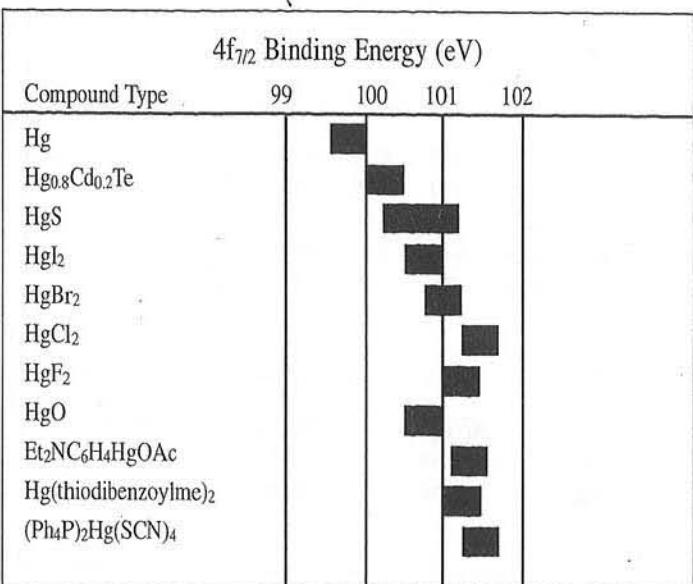
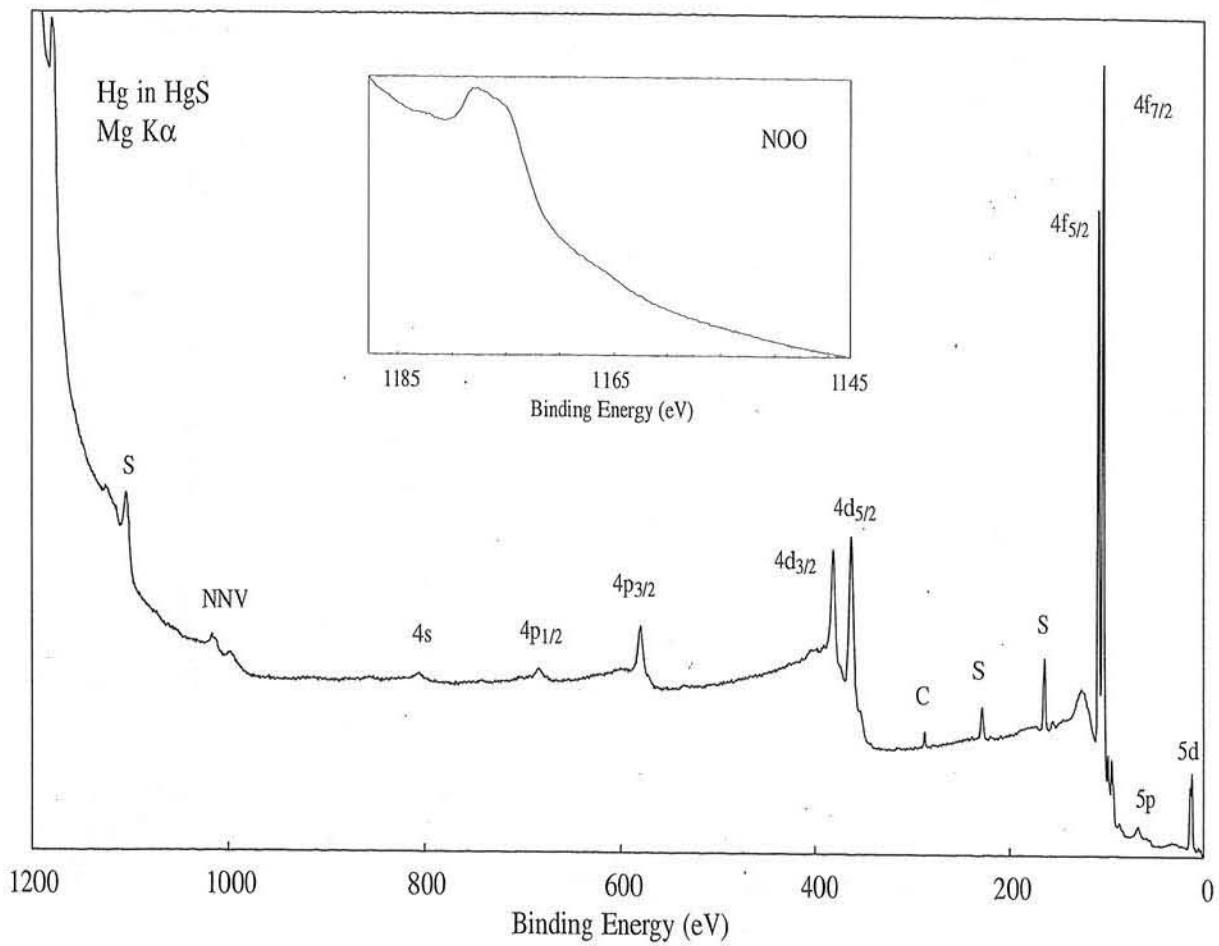


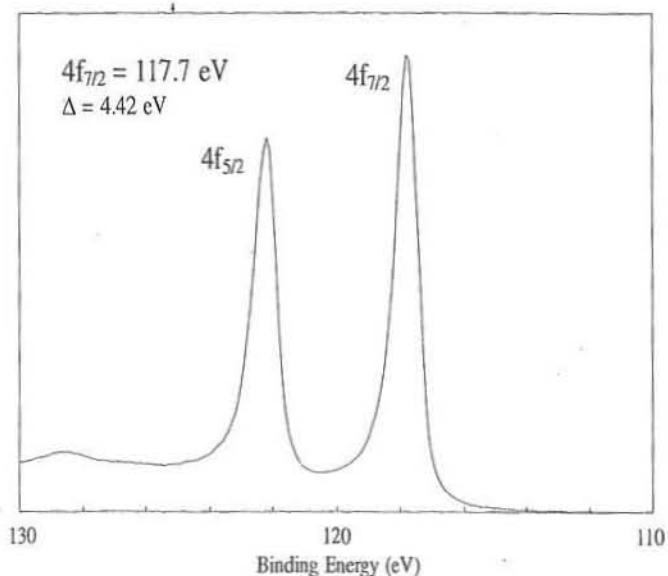
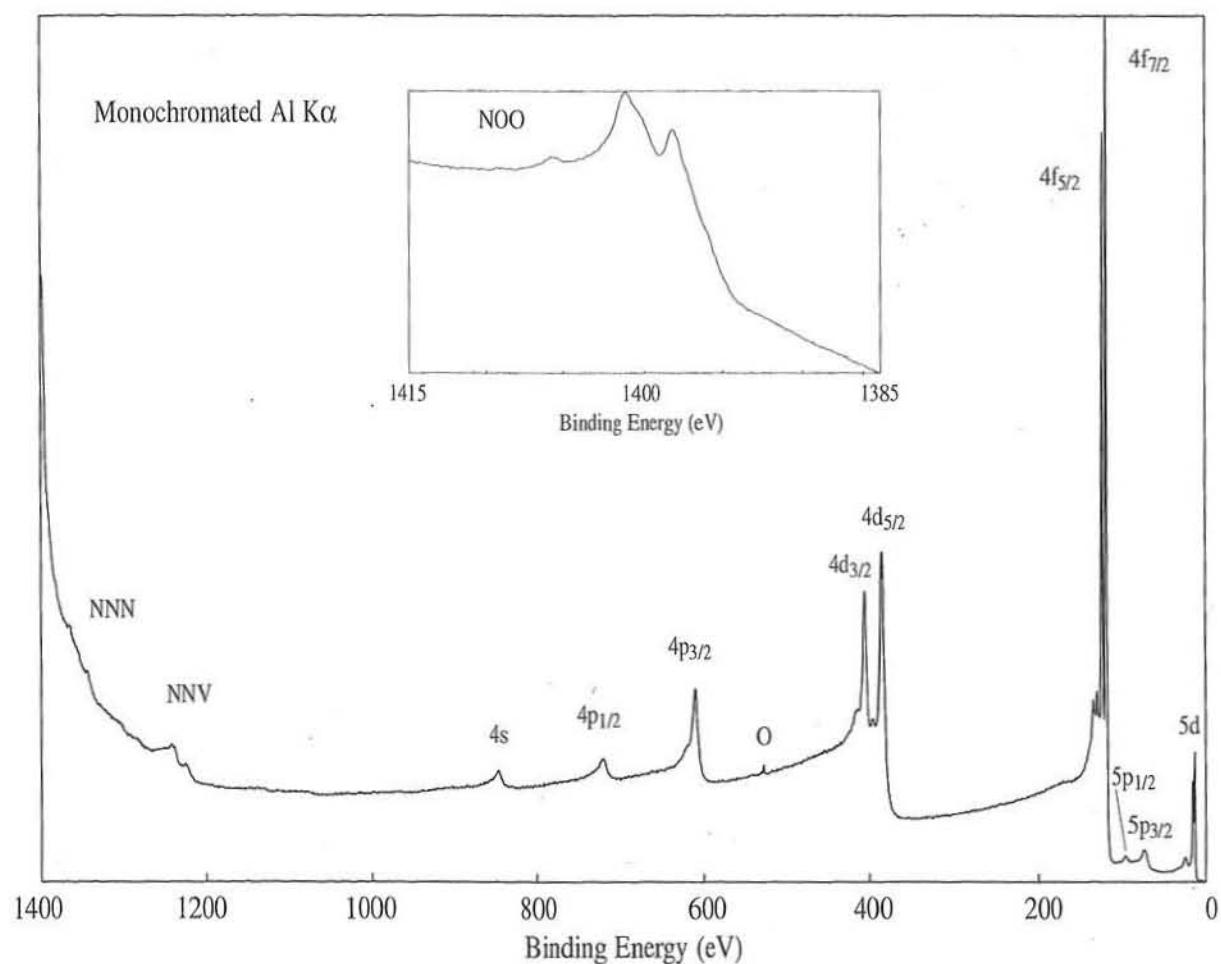
Line Positions (eV)				
Photoelectron Lines				
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>
763	643	547	353	335
Auger Lines				
N <sub>67</sub> O <sub>45</sub> O <sub>45</sub>	N <sub>5</sub> N <sub>6</sub> N <sub>67</sub>	N <sub>4</sub> N <sub>6</sub> N <sub>67</sub>	N <sub>5</sub> N <sub>67</sub> V	
1416	1342	1324	1247 (Al)	
1183	1109	1091	1014 (Mg)	

\*Estimate

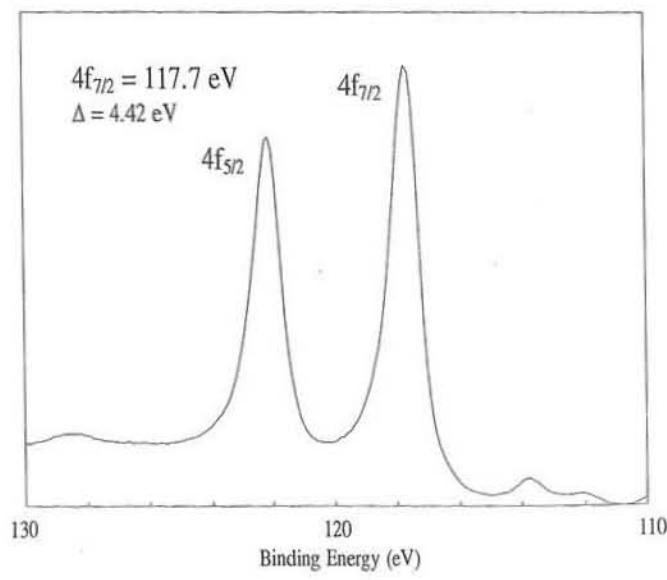
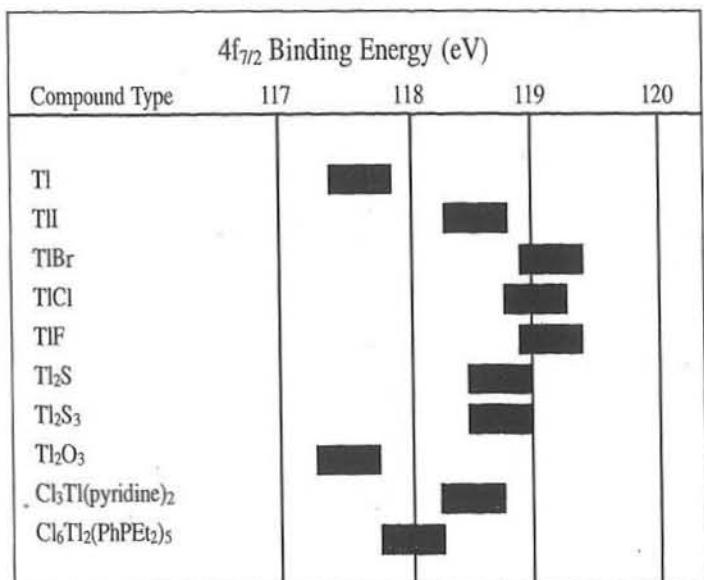
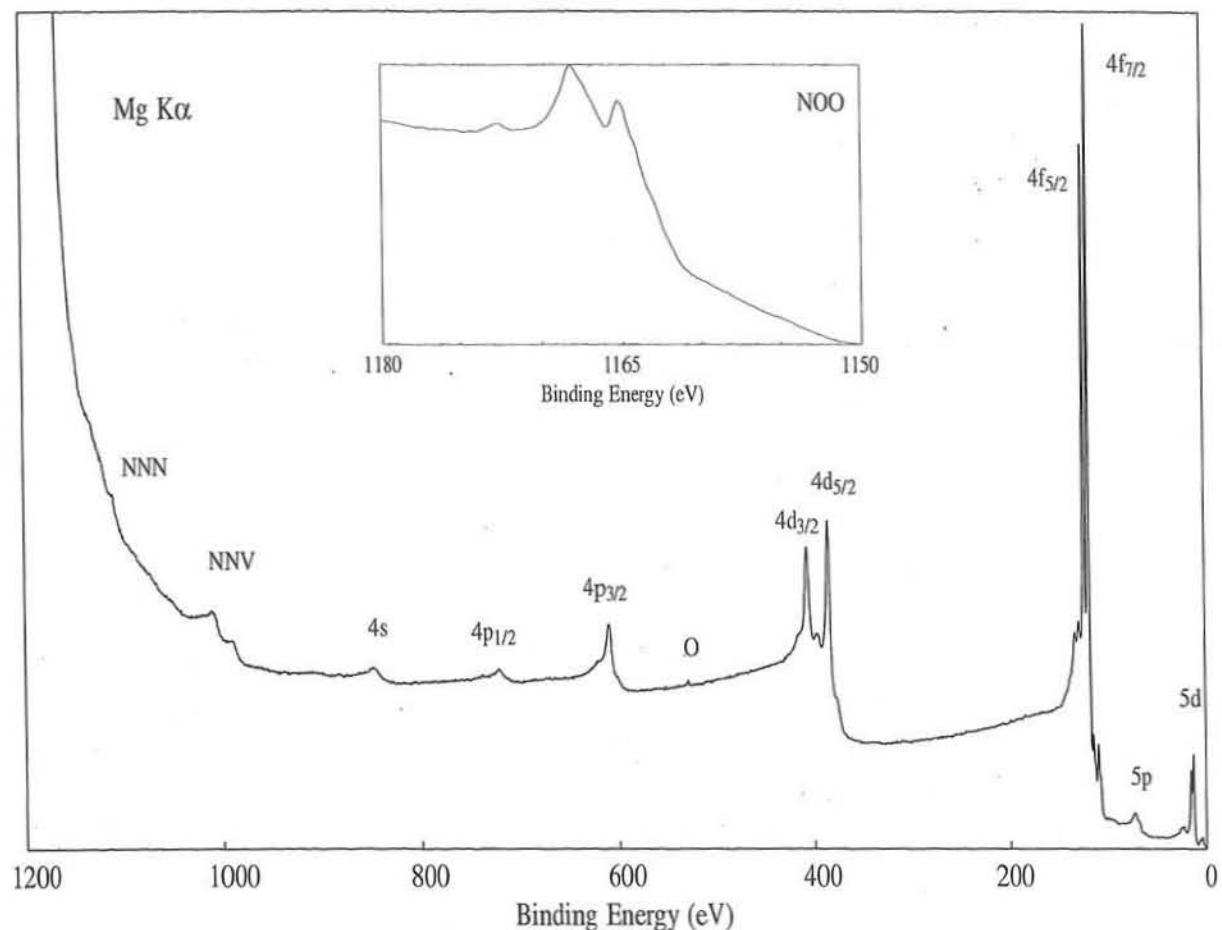


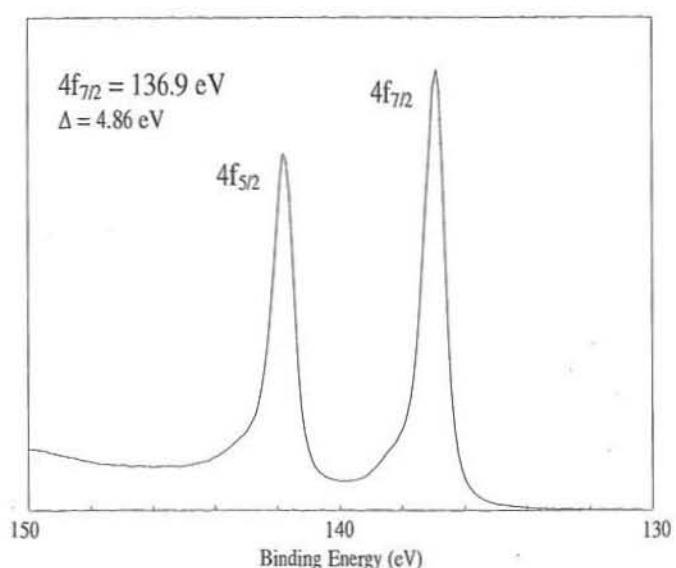
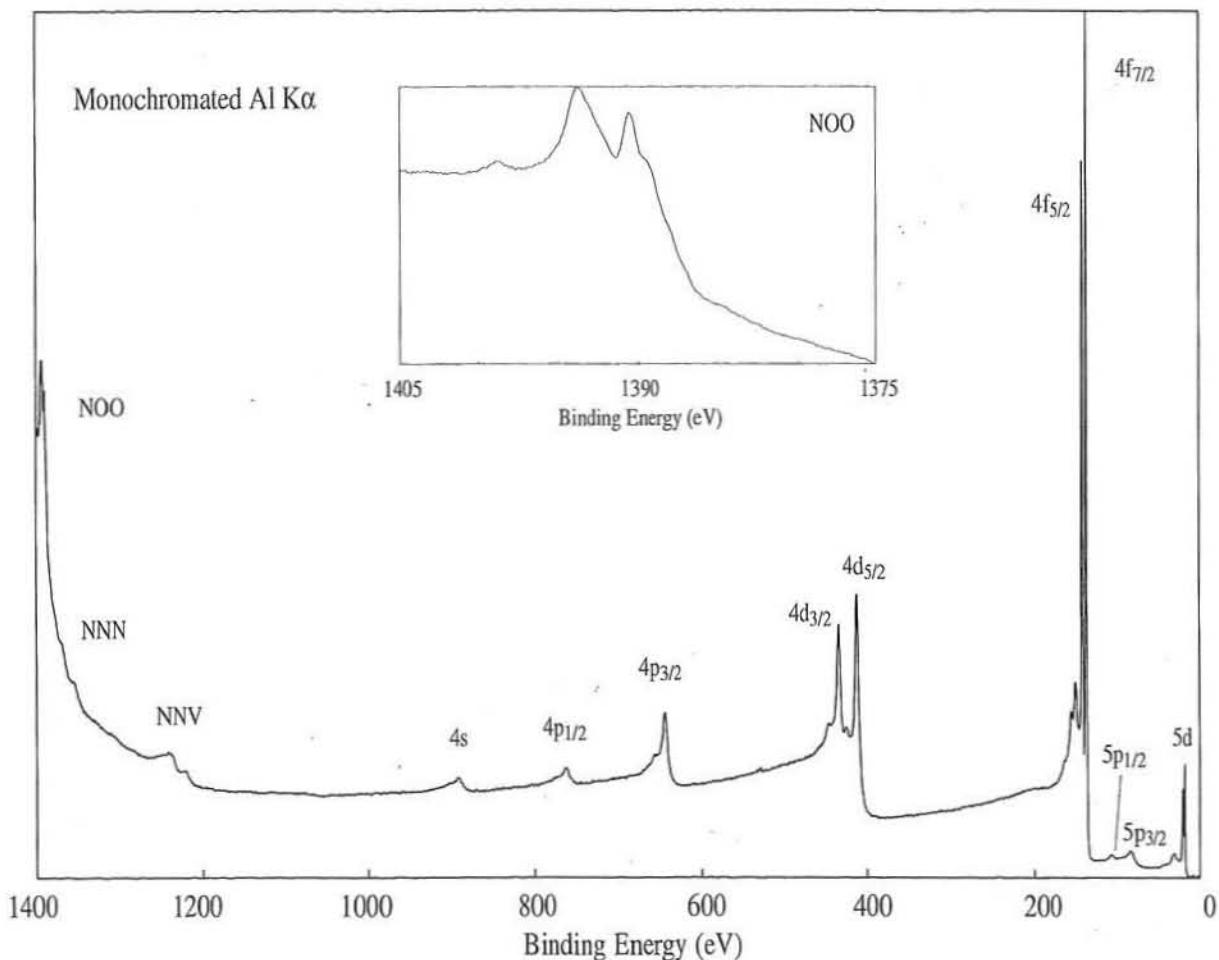






Line Positions (eV)					
Photoelectron Lines					
4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>	5s*
847	720	610	406	385	133
4f <sub>5/2</sub>	4f <sub>7/2</sub>	5p <sub>1/2</sub>	5p <sub>3/2</sub>	5d <sub>3/2</sub>	5d <sub>5/2</sub>
122	118	95	74	15	13
Auger Lines					
N <sub>7</sub> O <sub>45</sub> O <sub>45</sub>	N <sub>6</sub> O <sub>45</sub> O <sub>45</sub>	N <sub>5</sub> N <sub>7</sub> O <sub>5</sub>	N <sub>4</sub> N <sub>67</sub> O <sub>5</sub>		
1401	1399	1241	1222	(Al)	
1168	1166	1008	989	(Mg)	
*Estimate					





Line Positions (eV)

Photoelectron Lines

4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>	5s*
893	762	644	434	412	150

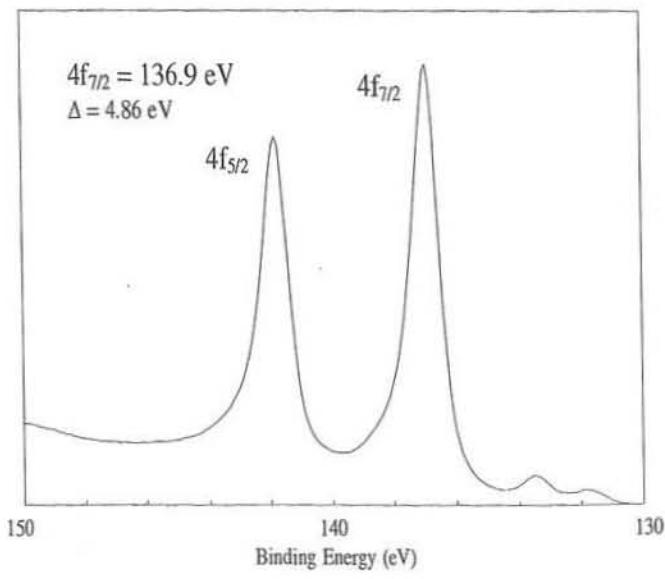
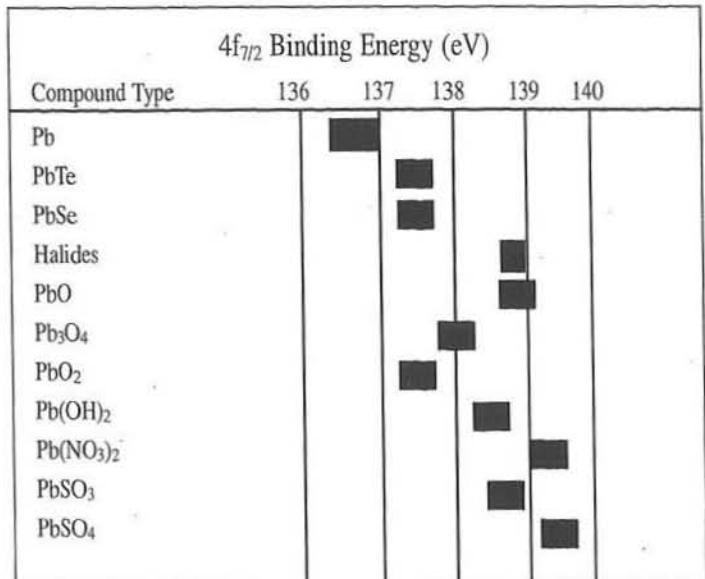
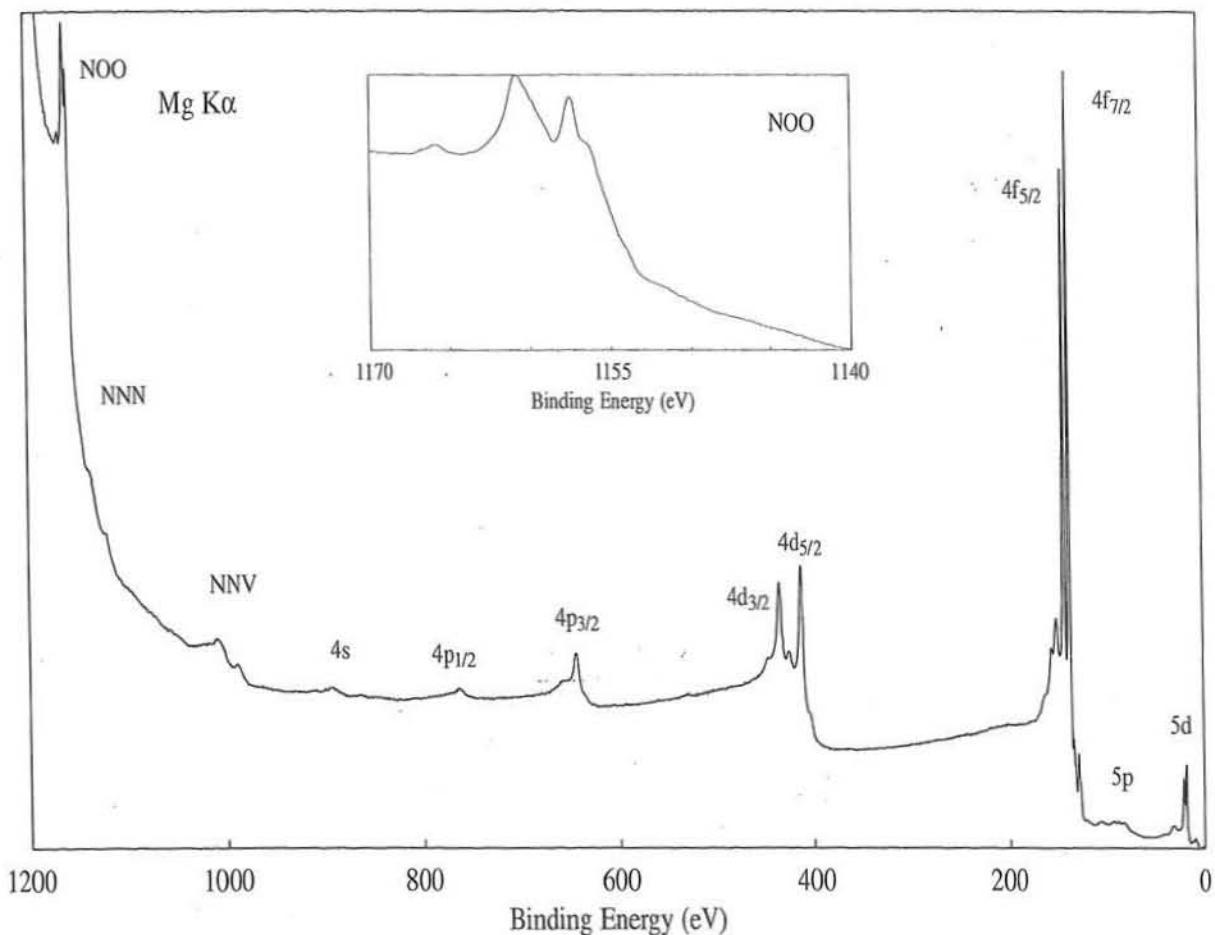
  

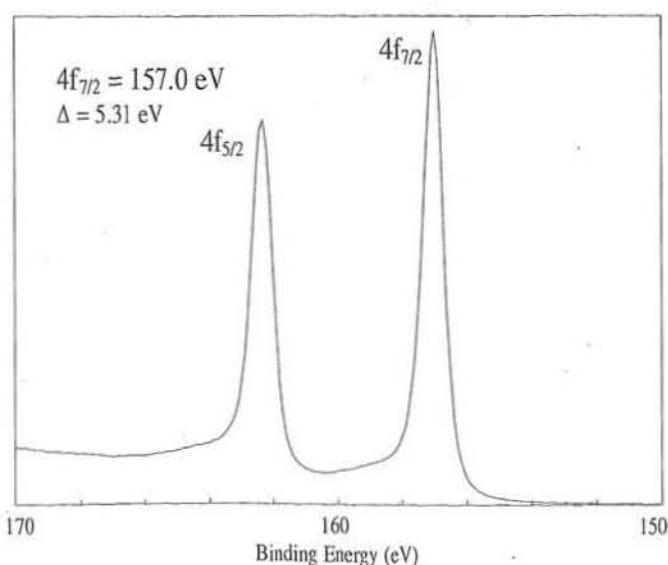
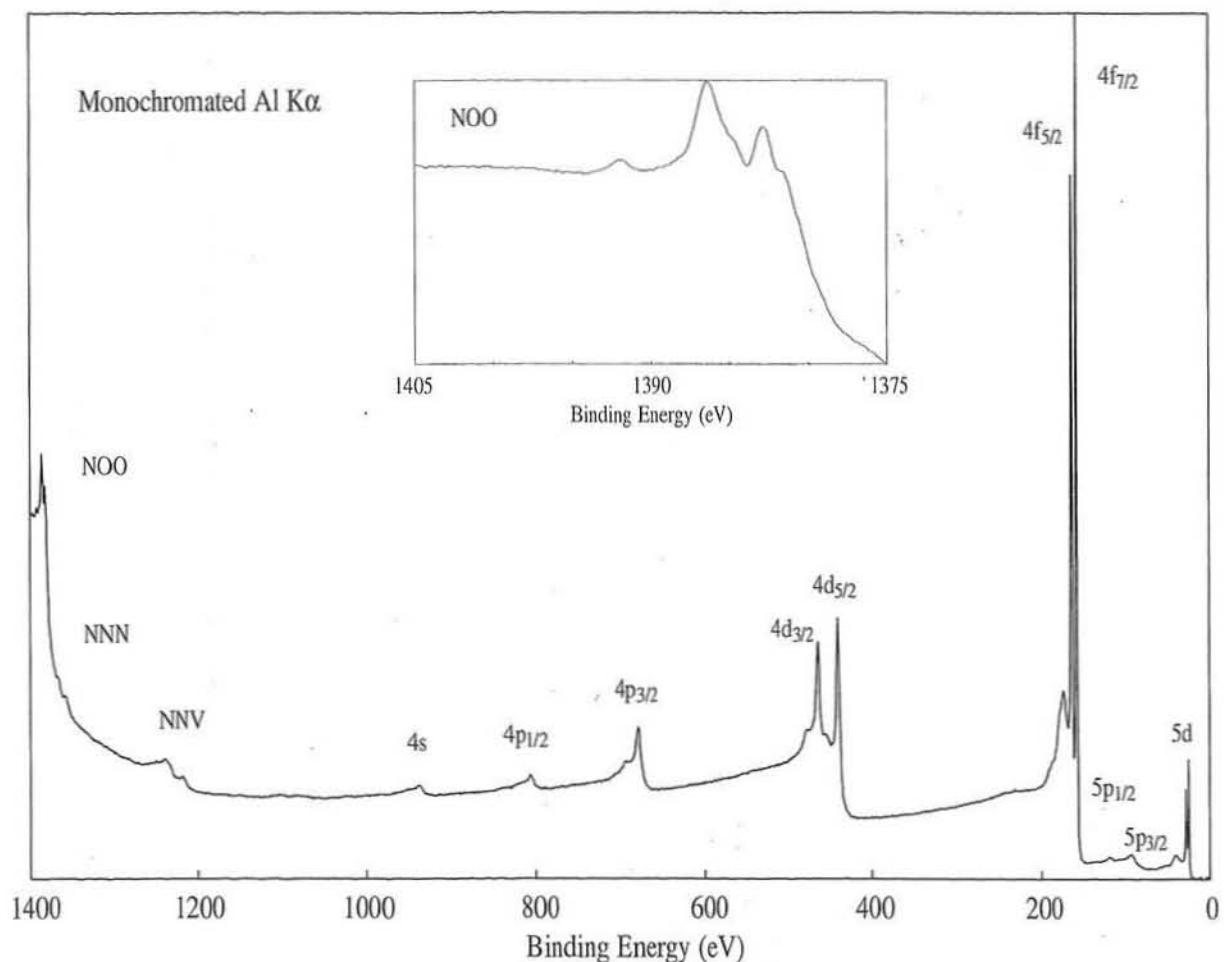
4f <sub>5/2</sub>	4f <sub>7/2</sub>	5p <sub>1/2</sub>	5p <sub>3/2</sub>	5d <sub>3/2</sub>	5d <sub>5/2</sub>
142	137	107	84	21	18

Auger Lines

N <sub>7</sub> O <sub>45</sub> O <sub>45</sub>	N <sub>6</sub> O <sub>45</sub> O <sub>45</sub>
1394	1391 (Al)
1161	1158 (Mg)

\*Estimate





Line Positions (eV)

Photoelectron Lines

4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>	5s*
940	806	679	464	440	161

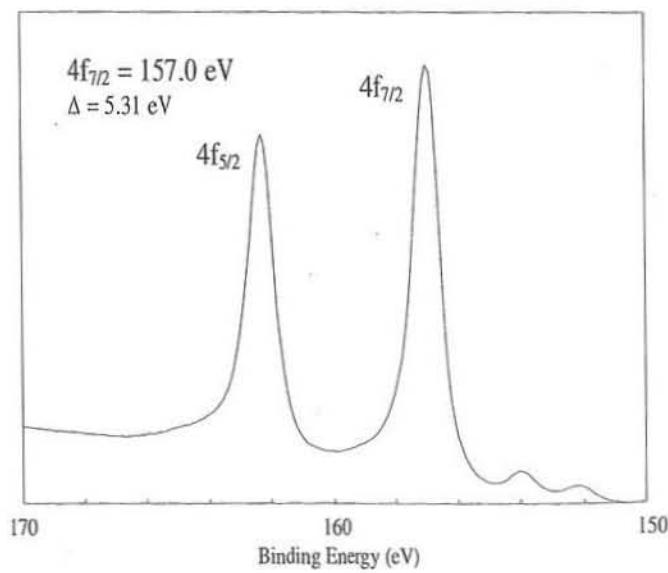
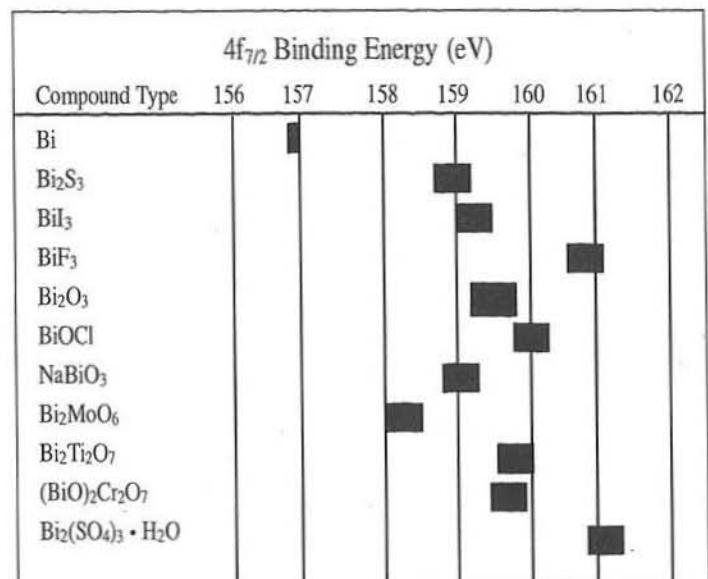
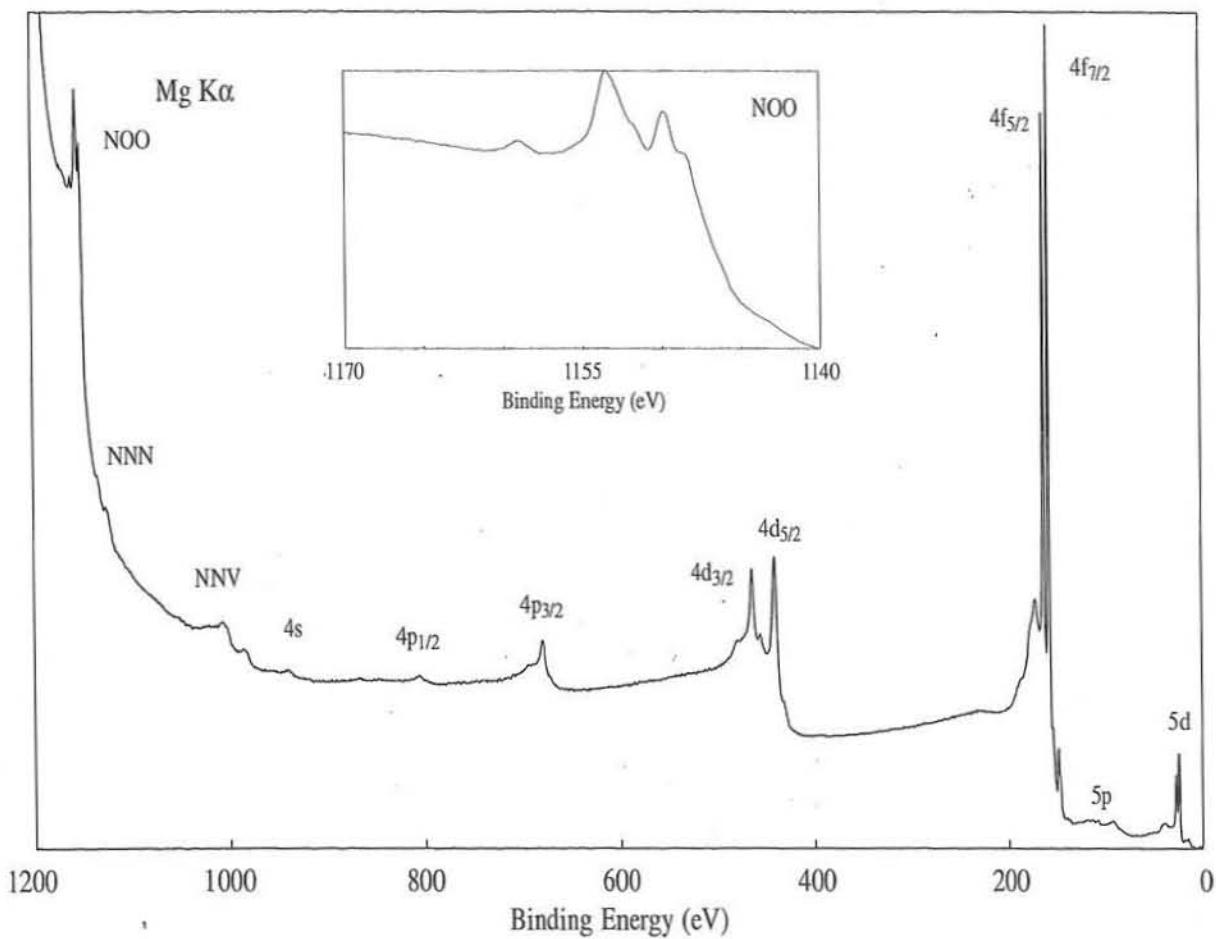
  

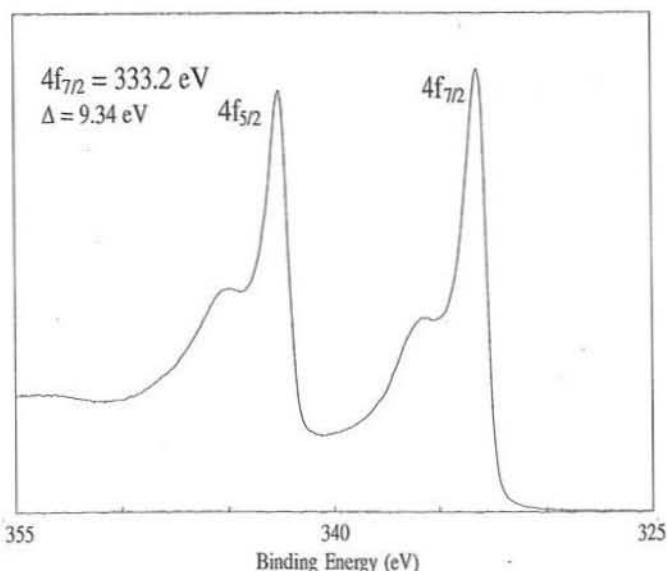
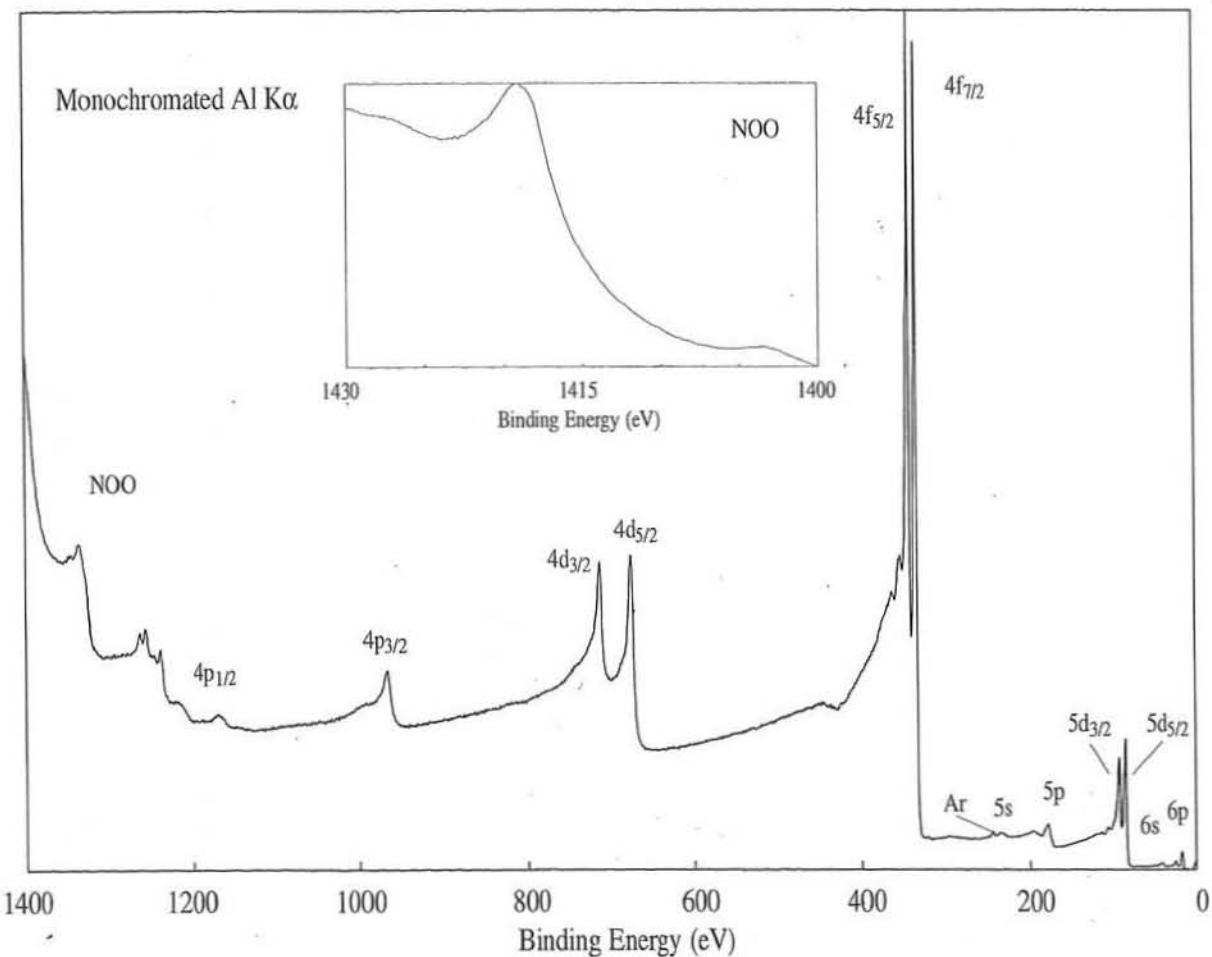
4f <sub>5/2</sub>	4f <sub>7/2</sub>	5p <sub>1/2</sub>	5p <sub>3/2</sub>	5d <sub>3/2</sub>	5d <sub>5/2</sub>
162	157	119	93	27	24

Auger Lines

N <sub>7</sub> O <sub>45</sub> O <sub>45</sub>	N <sub>6</sub> O <sub>45</sub> O <sub>45</sub>
1387	1383
1154	(Al)
	1150 (Mg)

\*Estimate





Line Positions (eV)

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Photoelectron Lines

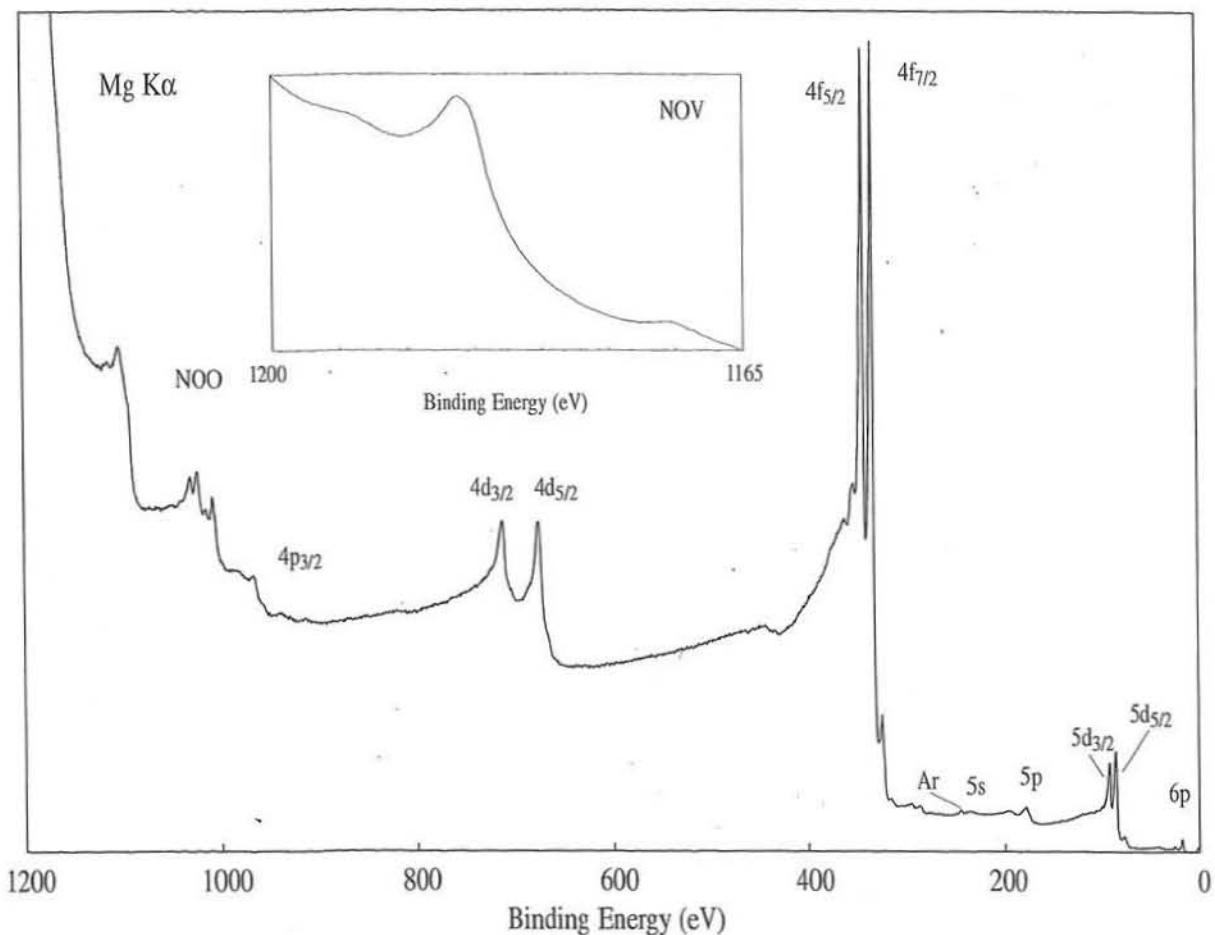
4s*	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>	4f <sub>5/2</sub>	4f <sub>7/2</sub>
1330	1170	965	713	676	342	333
294	234	177	93	85	42	25

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Auger Lines

N <sub>6</sub> O <sub>23</sub> V	N <sub>67</sub> O <sub>45</sub> O <sub>45</sub>	N <sub>7</sub> O <sub>4</sub> O <sub>5</sub>	N <sub>67</sub> O <sub>45</sub> V (Al)
1419	1404	1335	1239
1186	1171	1102	1006 (Mg)

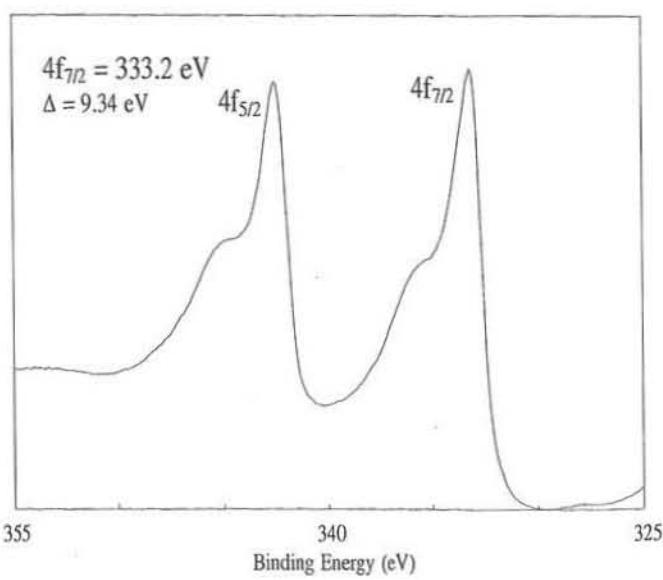
\*Estimate

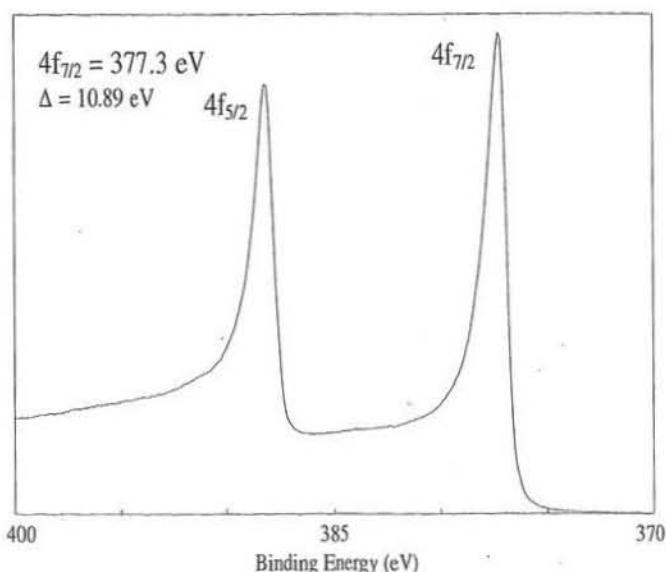
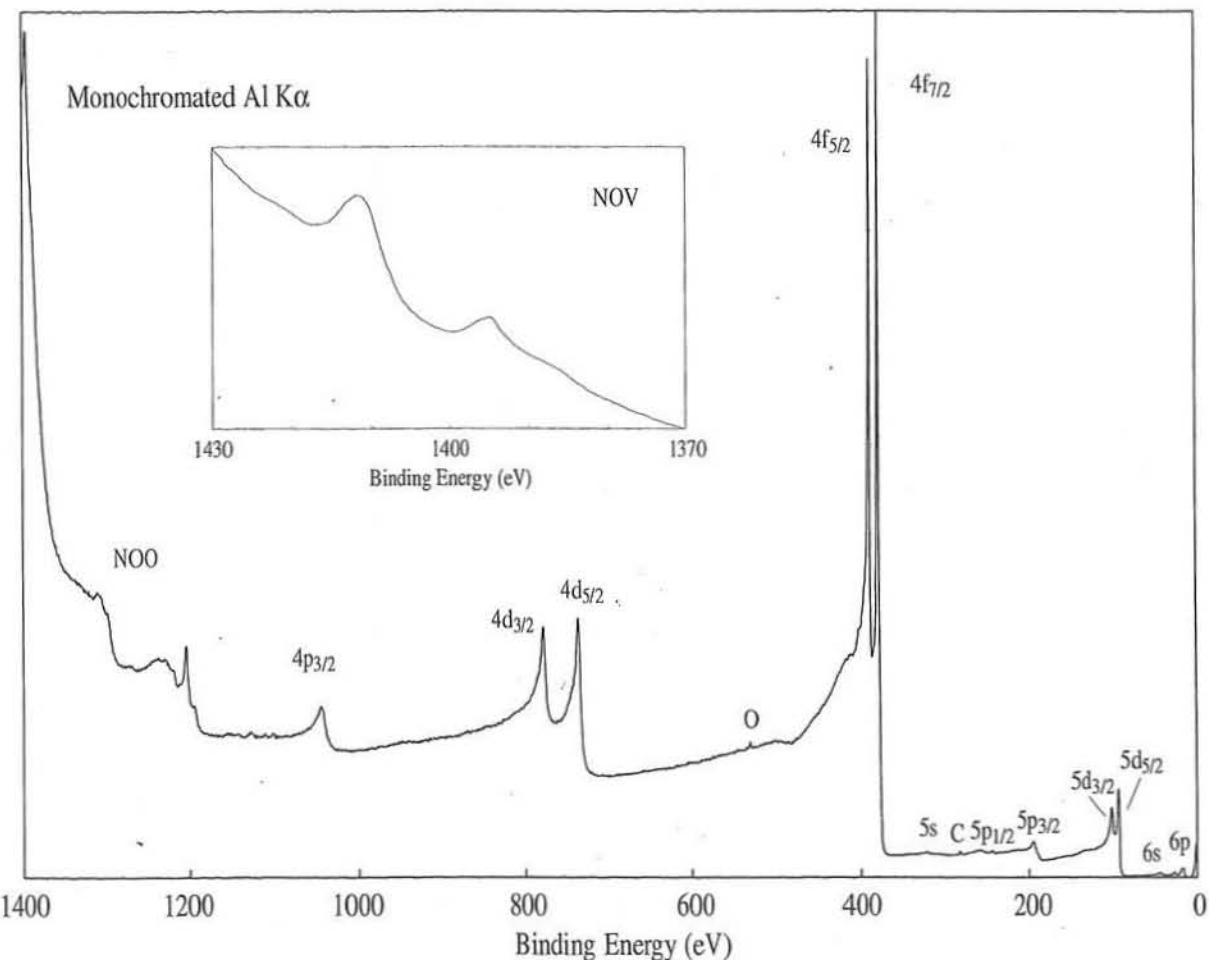


Compound Type	4f $_{7/2}$ Binding Energy (eV)				
	333	334	335	336	337
Th		■			
ThO <sub>2</sub>			■		
ThF <sub>4</sub>				■	

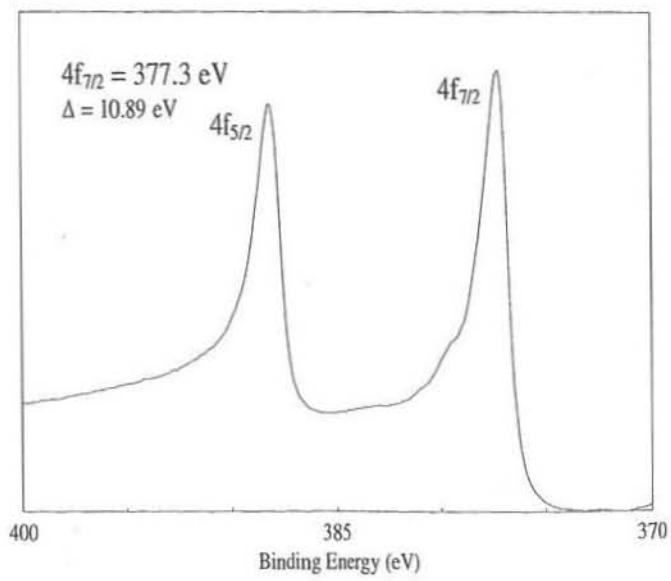
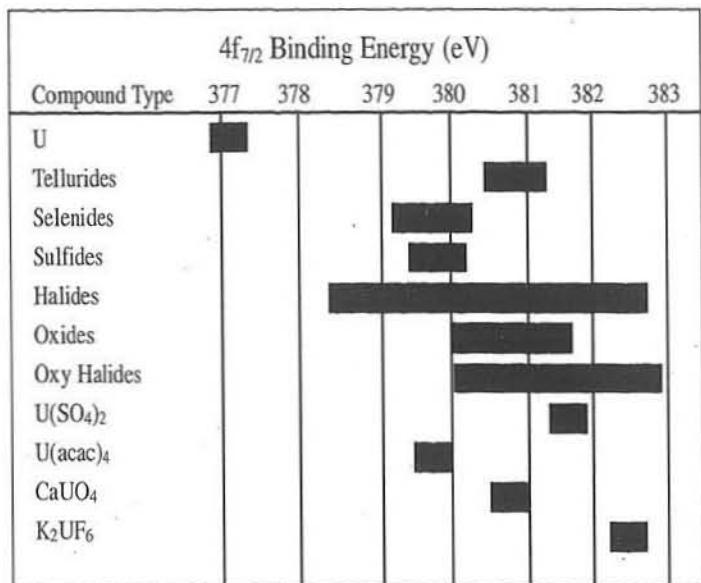
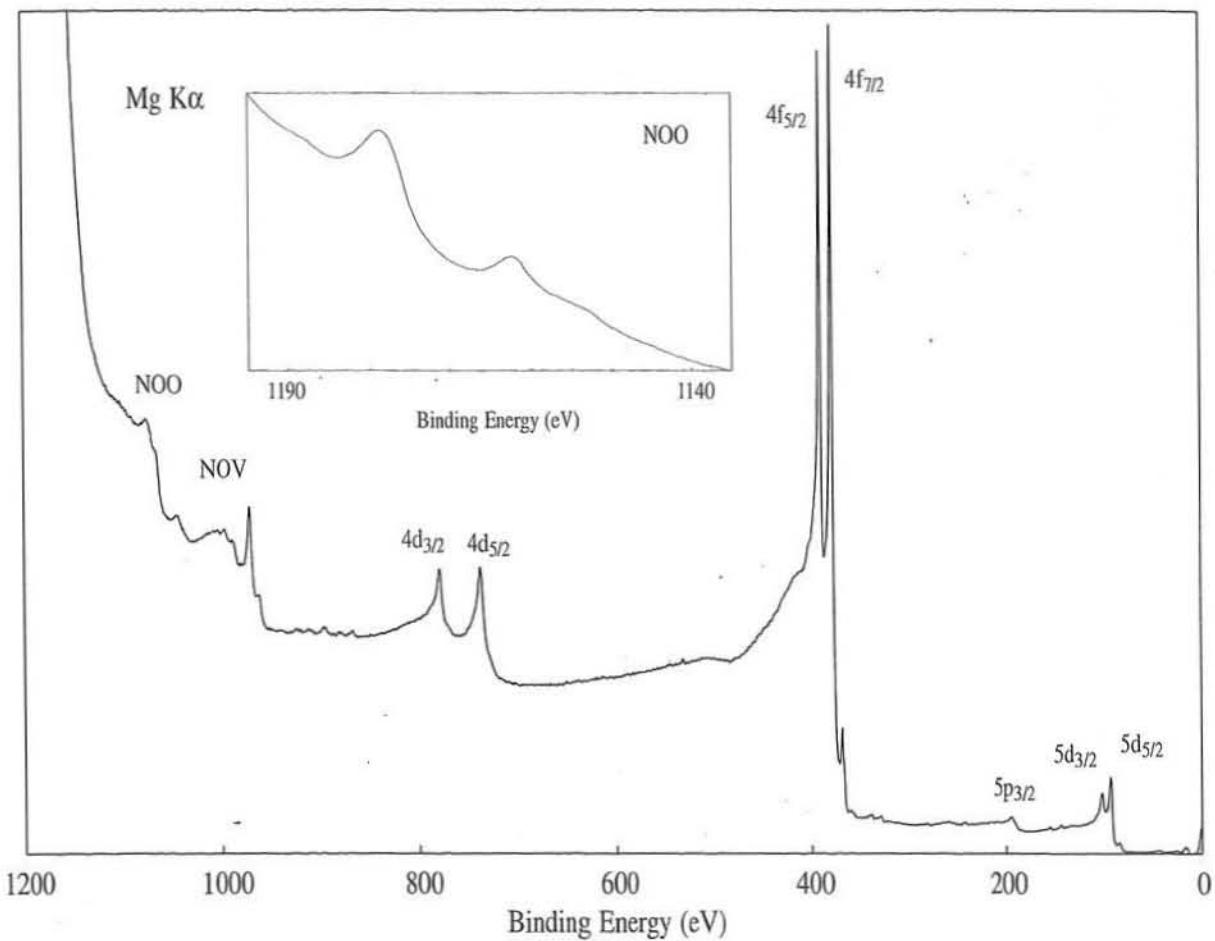
  

Compound Type	4d $_{5/2}$ Binding Energy (eV)		
	674	675	676
Th			
ThO <sub>2</sub>			■





Line Positions (eV)					
Photoelectron Lines					
4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>	4f <sub>5/2</sub>	4f <sub>7/2</sub>
1272	1043	779	736	388	377
322	260	195	103	94	44
				6s	6p <sub>1/2</sub> 6p <sub>3/2</sub>
				26	17
Auger Lines					
$N_6O_{23}V$		$N_7O_{23}O_5$		$N_6O_{45}O_{45}$	
1412		1396		1386	1204 (Al)
1179		1163		1153	971 (Mg)



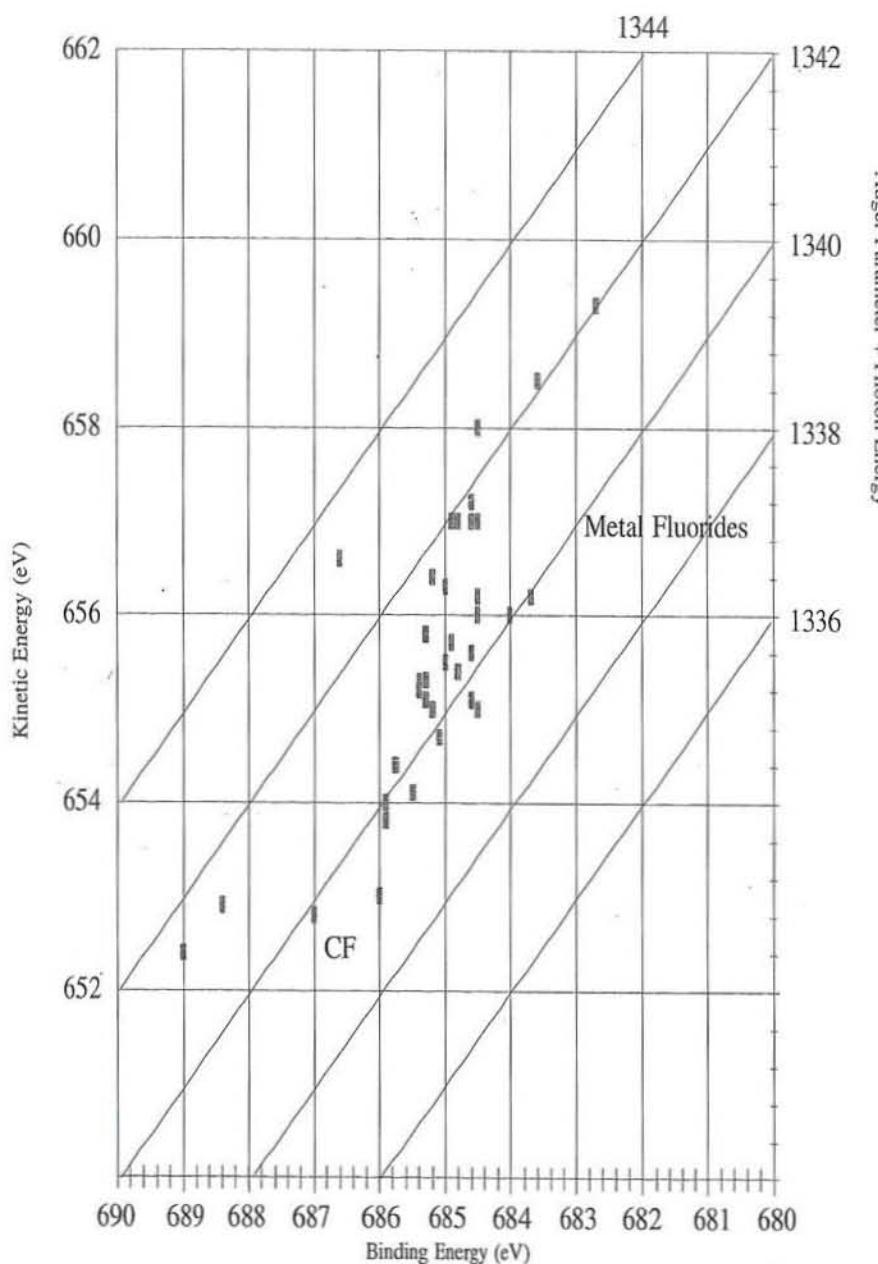


### **III. Appendix**

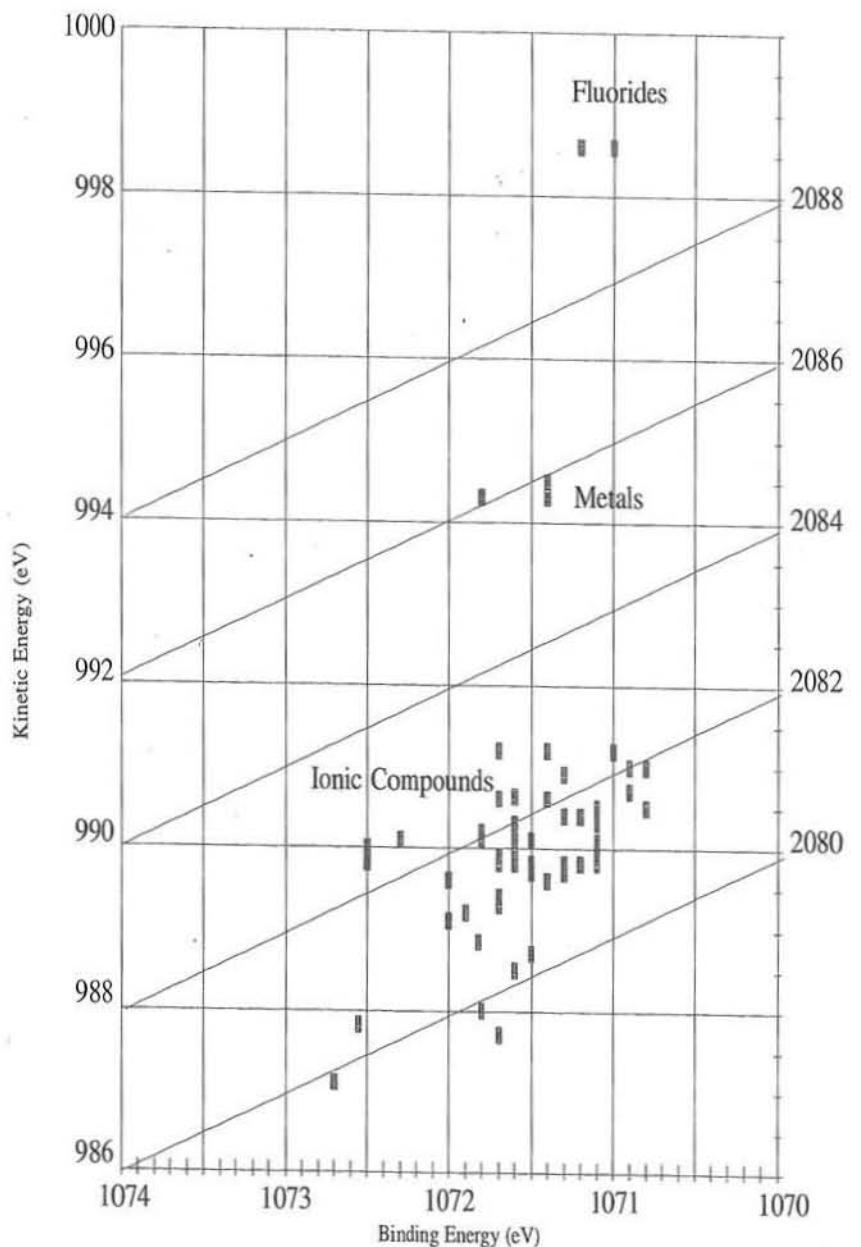
## Appendix A. Auger Parameters

The following tables plot the binding energy of the most intense photoelectron line versus the kinetic energy of the most intense Auger transition. The Auger parameter plots are useful for further separation of the chemical states.

Fluorine		
Compound	F 1s Binding Energy (eV)	F KLL Kinetic Energy (eV)
AgF	682.7	659.3
PbF <sub>2</sub>	683.6	658.5
BaF <sub>2</sub>	683.7	656.2
K <sub>3</sub> FeF <sub>6</sub>	684.0	656.0
NaF	684.5	655.0
CdF <sub>2</sub>	684.5	656.0
CuF <sub>2</sub>	684.5	657.0
CuF <sub>2</sub>	684.5	656.2
CuF <sub>2</sub>	684.5	656.2
LaF <sub>3</sub>	684.5	658.0
ZnF <sub>2</sub>	684.6	655.6
PrF <sub>3</sub>	684.6	657.2
SmF <sub>3</sub>	684.6	657.0
K <sub>2</sub> ZrF <sub>6</sub>	684.6	655.1
CaF <sub>2</sub>	684.8	655.4
NdF <sub>3</sub>	684.8	657.0
ThF <sub>4</sub>	684.9	657.0
K <sub>2</sub> TiF <sub>6</sub>	684.9	655.7
SrF <sub>2</sub>	685.0	656.3
NiF <sub>2</sub>	685.0	655.5
LiF	685.1	654.7
InF <sub>3</sub>	685.2	656.4
K <sub>2</sub> TaF <sub>7</sub>	685.2	655.0
YF <sub>3</sub>	685.3	655.8
Na <sub>2</sub> TiF <sub>6</sub>	685.3	655.1
NaSnF <sub>3</sub>	685.3	655.3
HfF <sub>4</sub>	685.4	655.3
K <sub>2</sub> NbF <sub>7</sub>	685.4	655.2
Na <sub>3</sub> AlF <sub>6</sub>	685.5	654.1
MgF <sub>2</sub>	685.8	654.4
CsF	685.9	653.8
Na <sub>2</sub> GeF <sub>6</sub>	685.9	654.0
Na <sub>2</sub> SiF <sub>6</sub>	686.0	653.0
KSbF <sub>6</sub>	686.6	656.6
NaBF <sub>4</sub>	687.0	652.8
NiOOCCF <sub>3</sub>	688.4	652.9
p-(CF <sub>2</sub> =CF <sub>2</sub> )	689.0	652.4

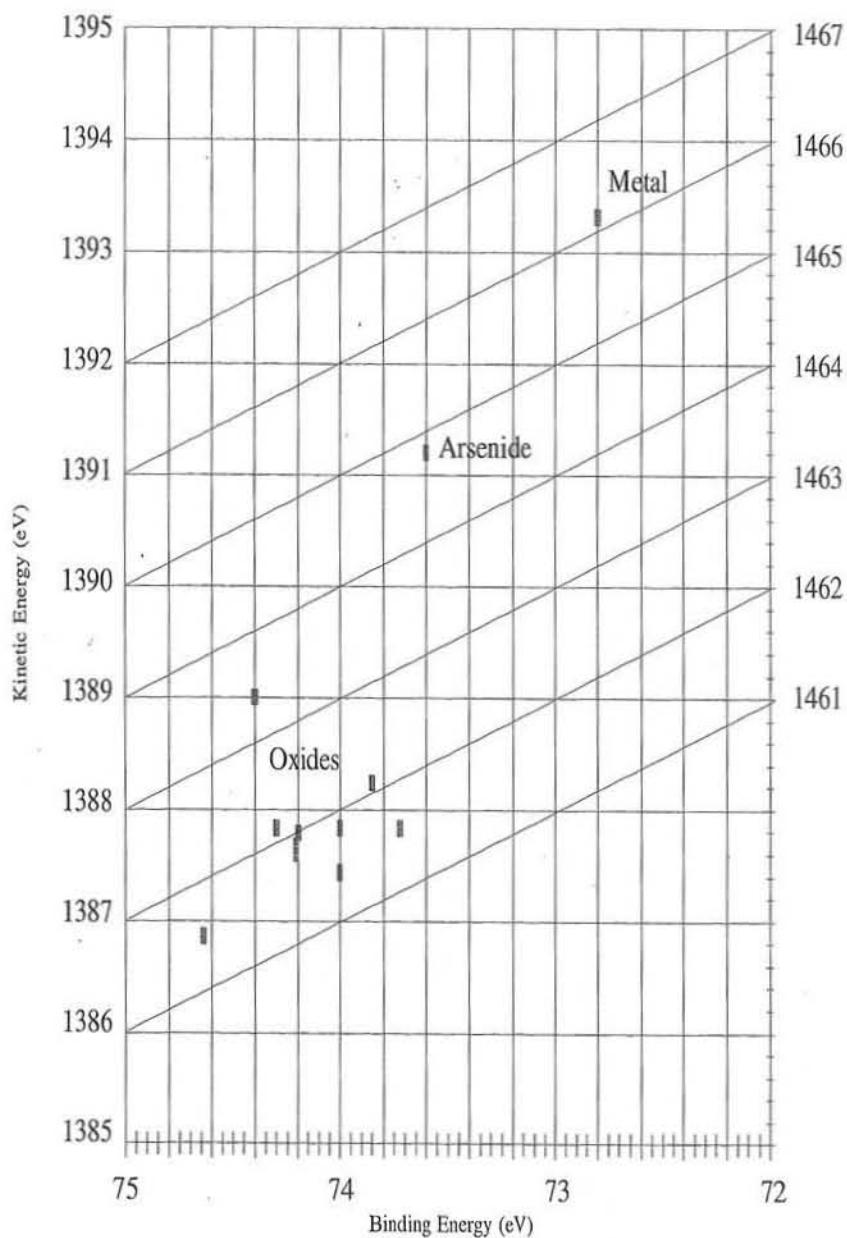


Sodium		
Compound	Na 1s Binding Energy (eV)	Na KLL Kinetic Energy (eV)
Na <sub>2</sub> SeO <sub>3</sub>	1070.8	991.0
Na <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	1070.8	990.5
Na <sub>2</sub> MoO <sub>4</sub>	1070.9	991.0
NaAsO <sub>2</sub>	1070.9	990.7
NaF	1071.0	998.6
Na <sub>2</sub> CrO <sub>4</sub>	1071.0	991.2
Na <sub>3</sub> PO <sub>4</sub>	1071.1	990.1
NaH <sub>2</sub> PO <sub>2</sub>	1071.1	989.8
Na <sub>2</sub> SnO <sub>3</sub> · 3H <sub>2</sub> O	1071.1	990.3
NaOAc	1071.1	989.9
NaF	1071.2	998.6
Na <sub>2</sub> SO <sub>4</sub>	1071.2	989.8
NaOOCCH <sub>2</sub> SH	1071.2	990.4
Na <sub>2</sub> SO <sub>3</sub>	1071.3	990.4
Na	1071.4	994.3
Na	1071.4	994.5
NaBr	1071.4	990.6
NaNO <sub>3</sub>	1071.4	989.6
Na <sub>2</sub> CrO <sub>4</sub>	1071.4	991.2
NaCl	1071.5	990.1
Na <sub>2</sub> CO <sub>3</sub>	1071.5	989.8
Na <sub>2</sub> HPO <sub>4</sub>	1071.5	989.7
Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	1071.6	990.1
NaNO <sub>2</sub>	1071.6	989.8
Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	1071.6	990.6
NaI	1071.7	991.2
NaBr	1071.7	990.6
Na <sub>2</sub> CO <sub>3</sub>	1071.7	989.8
NaOAc	1071.7	989.9
Na	1071.8	994.3
NaCl	1071.8	990.1
NaCl	1072.5	990.0
Na <sub>2</sub> O	1072.5	989.8
Mol Sieve Y	1072.6	987.8
NaBF <sub>4</sub>	1072.7	987.1

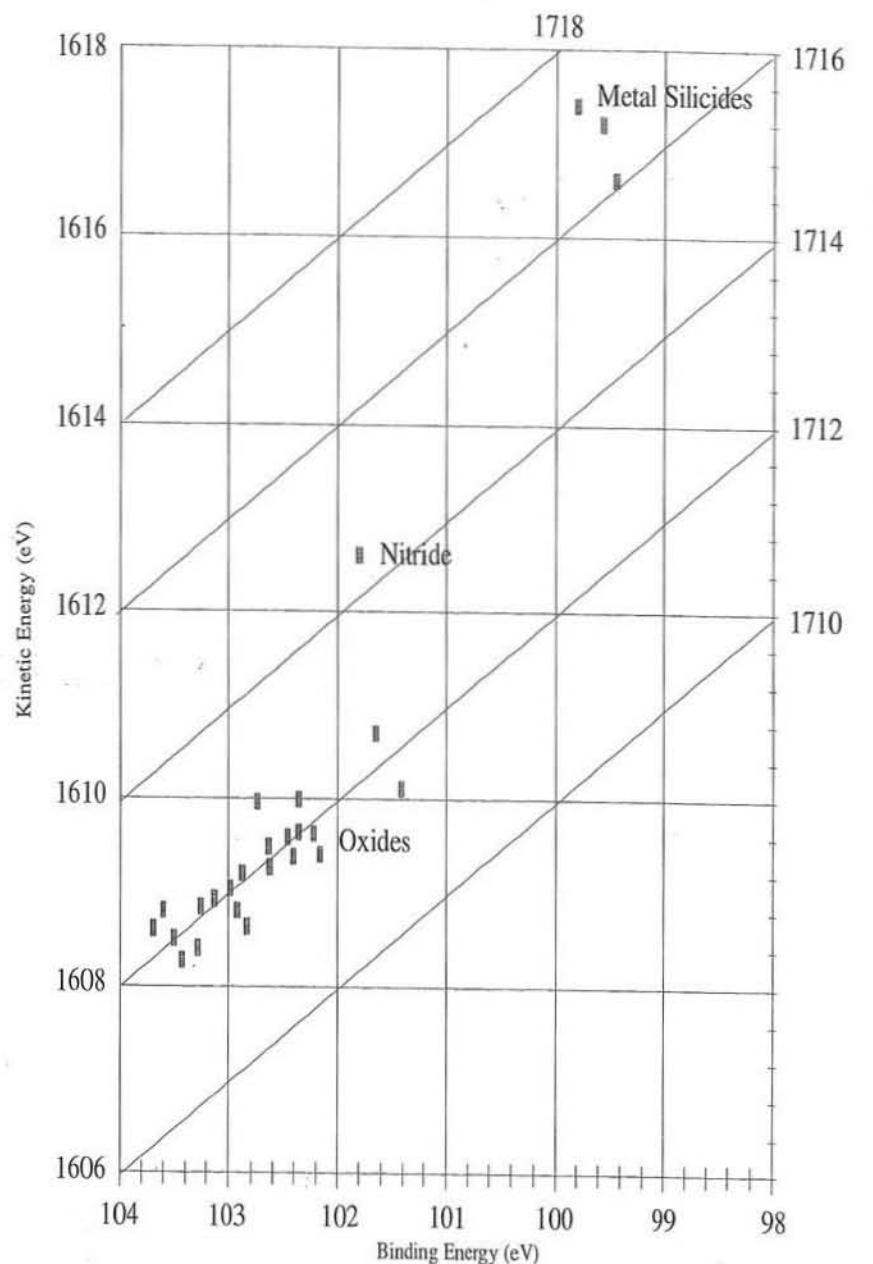


Auger Parameter + Photon Energy

Aluminum		
Compound	Al 2p Binding Energy (eV)	Al KLL Kinetic Energy (eV)
Al	72.8	1393.3
AlAs	73.6	1391.2
Al <sub>2</sub> O <sub>3</sub> , gamma	73.7	1387.8
Al <sub>2</sub> O <sub>3</sub> , alpha	73.9	1388.2
Al <sub>2</sub> O <sub>3</sub> , gamma	74.0	1387.8
Al(OH) <sub>3</sub> , gibbsite	74.0	1387.4
Al <sub>2</sub> O <sub>3</sub> , sapphire	74.2	1387.8
AlOOH, boehmite	74.2	1387.6
Al(OH) <sub>3</sub> , bayerite	74.2	1387.7
Al <sub>2</sub> O <sub>3</sub> , gamma	74.3	1387.8
AlN	74.4	1389.0
Al <sub>2</sub> SiO <sub>5</sub> , sillimanite	74.6	1386.9

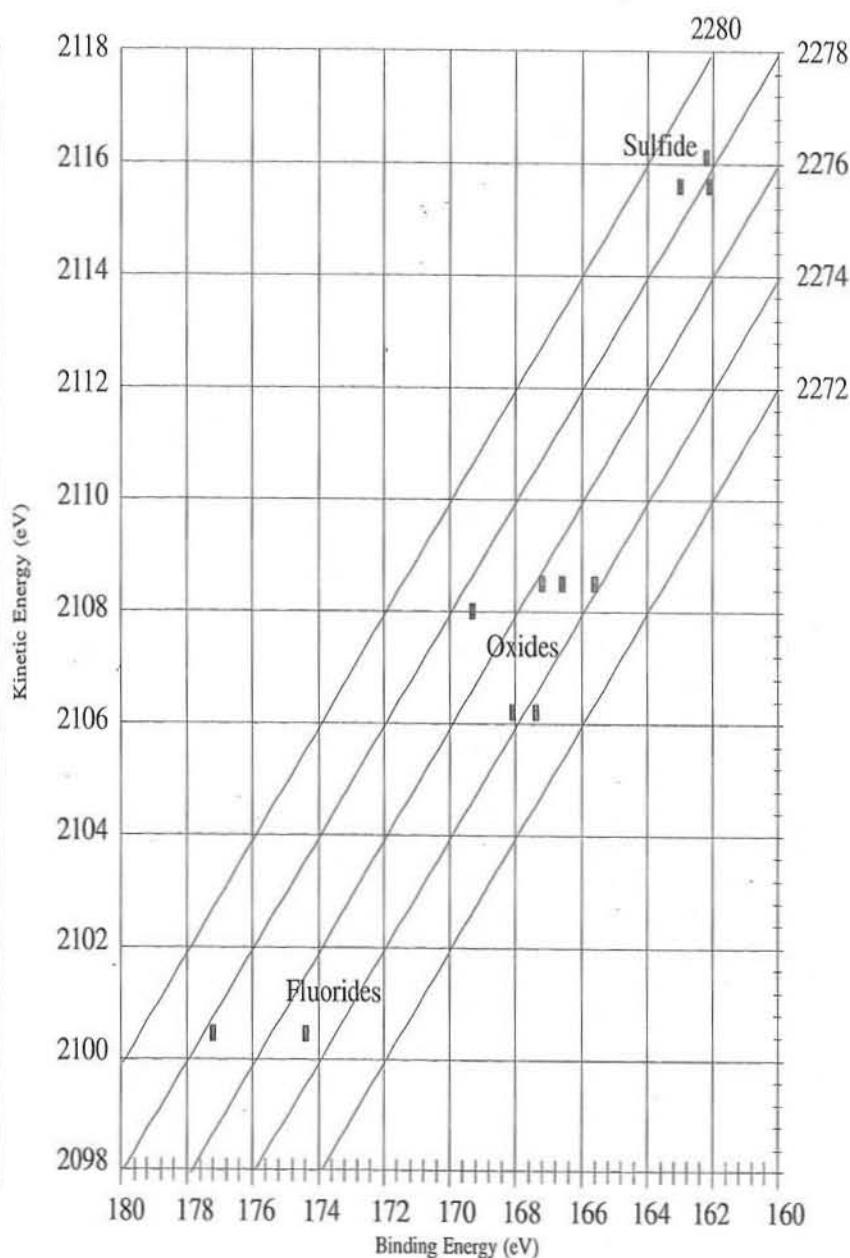


Silicon		
Compound	Si 2p Binding Energy (eV)	Si (KLL) Kinetic Energy (eV)
Si	99.5	1616.6
MoSi <sub>2</sub>	99.6	1617.2
PdSi	99.8	1617.4
Mol Sieve A	101.4	1610.1
Hydroxysodalite	101.7	1610.7
Si <sub>3</sub> N <sub>4</sub>	101.8	1612.6
Mol Sieve X	102.2	1609.4
Natrolite	102.2	1609.6
Mica, muscovite	102.4	1609.6
Wollastonite, Ca <sub>3</sub> Si <sub>3</sub> O <sub>9</sub>	102.4	1610.0
p-Methylsil. (linear)	102.4	1609.4
LiAlSi <sub>2</sub> O <sub>6</sub> , spodumene	102.5	1609.6
NaAlSi <sub>3</sub> O <sub>8</sub> , albite	102.6	1609.2
AlSiO <sub>5</sub> , sillimanite	102.6	1609.5
p-Phenylsil. (resin)	102.7	1610.0
Mol Sieve Y	102.8	1608.7
Pyrophyllite	102.9	1609.2
p-Methylsil. (resin)	102.9	1608.8
Kaolinite	103.0	1609.0
Talc, Mg <sub>3</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	103.1	1608.9
SiO <sub>2</sub> , alpha cristobal	103.3	1608.8
H Zeolon	103.3	1608.4
SiO <sub>2</sub> , gel	103.4	1608.3
SiO <sub>2</sub> , Vycor	103.5	1608.5
SiO <sub>2</sub>	103.6	1608.8
SiO <sub>2</sub> , quartz	103.7	1608.6

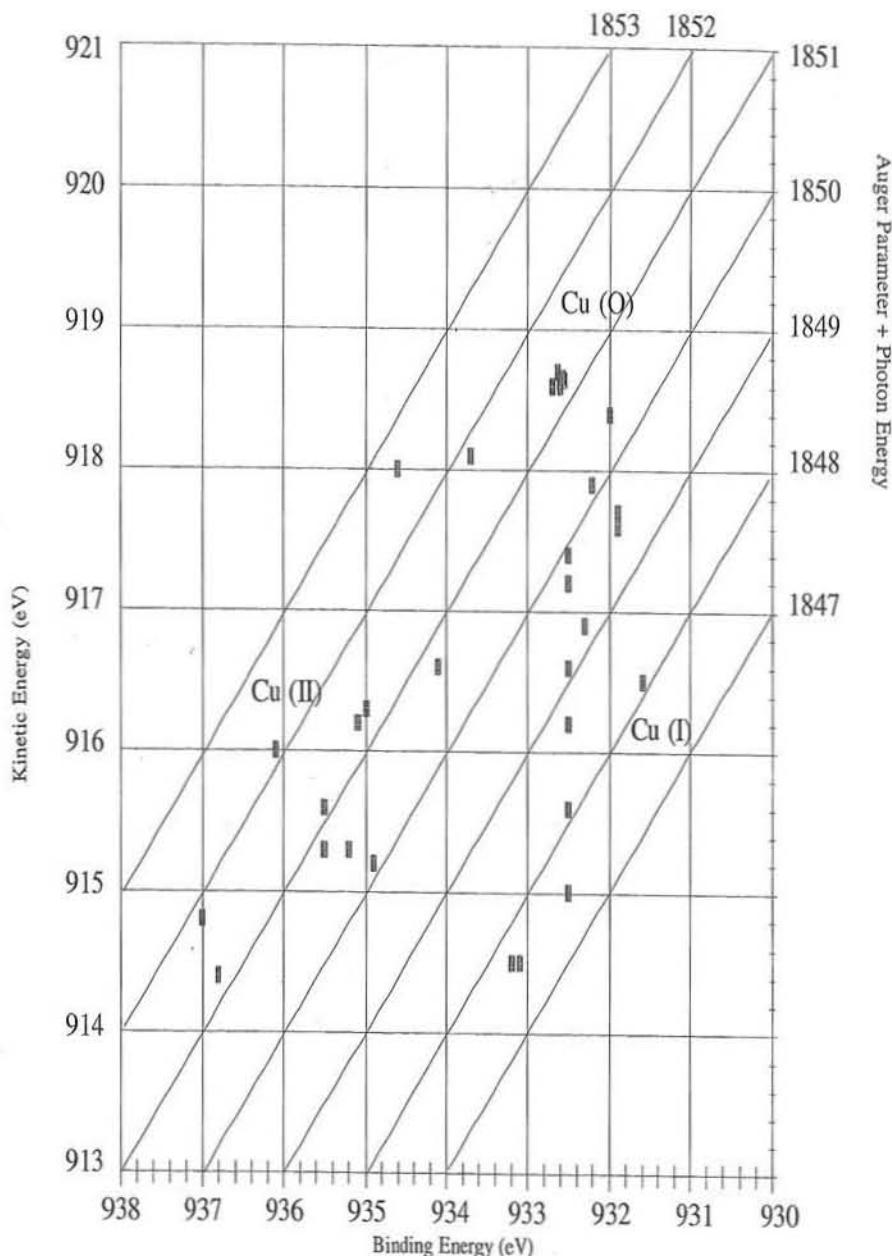


Auger Parameter + Photon Energy

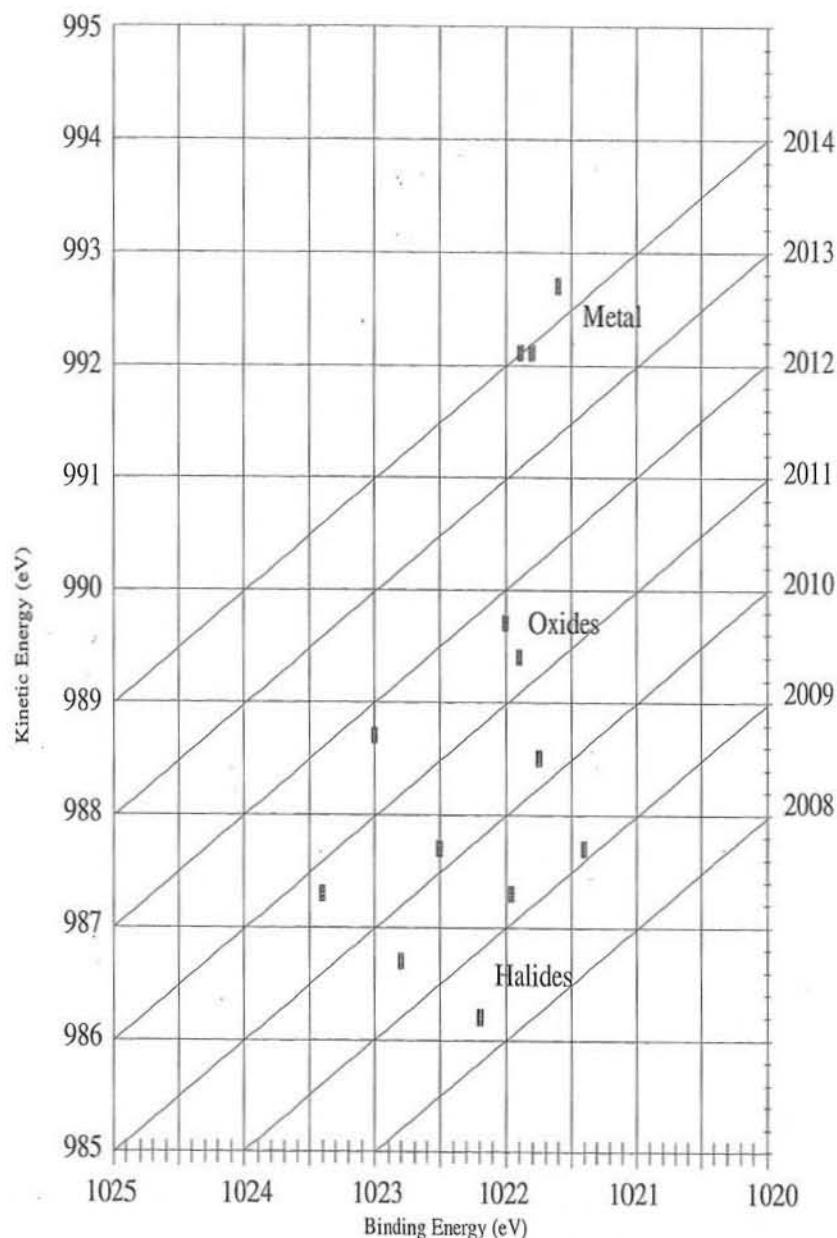
Sulfur		
Compound	S 2p Binding Energy (eV)	S KLL Kinetic Energy (eV)
WS <sub>2</sub>	162.1	2115.6
NiS	162.2	2116.1
WS <sub>2</sub>	163.0	2115.6
Na <sub>2</sub> SO <sub>3</sub>	165.6	2108.5
Na <sub>2</sub> SO <sub>3</sub>	166.6	2108.5
Na <sub>2</sub> SO <sub>3</sub>	167.2	2108.5
SO <sub>2</sub>	167.4	2106.2
SO <sub>2</sub>	168.1	2106.2
CuSO <sub>4</sub>	169.3	2108.0
SF <sub>6</sub>	174.4	2100.5
SF <sub>6</sub>	177.2	2100.5



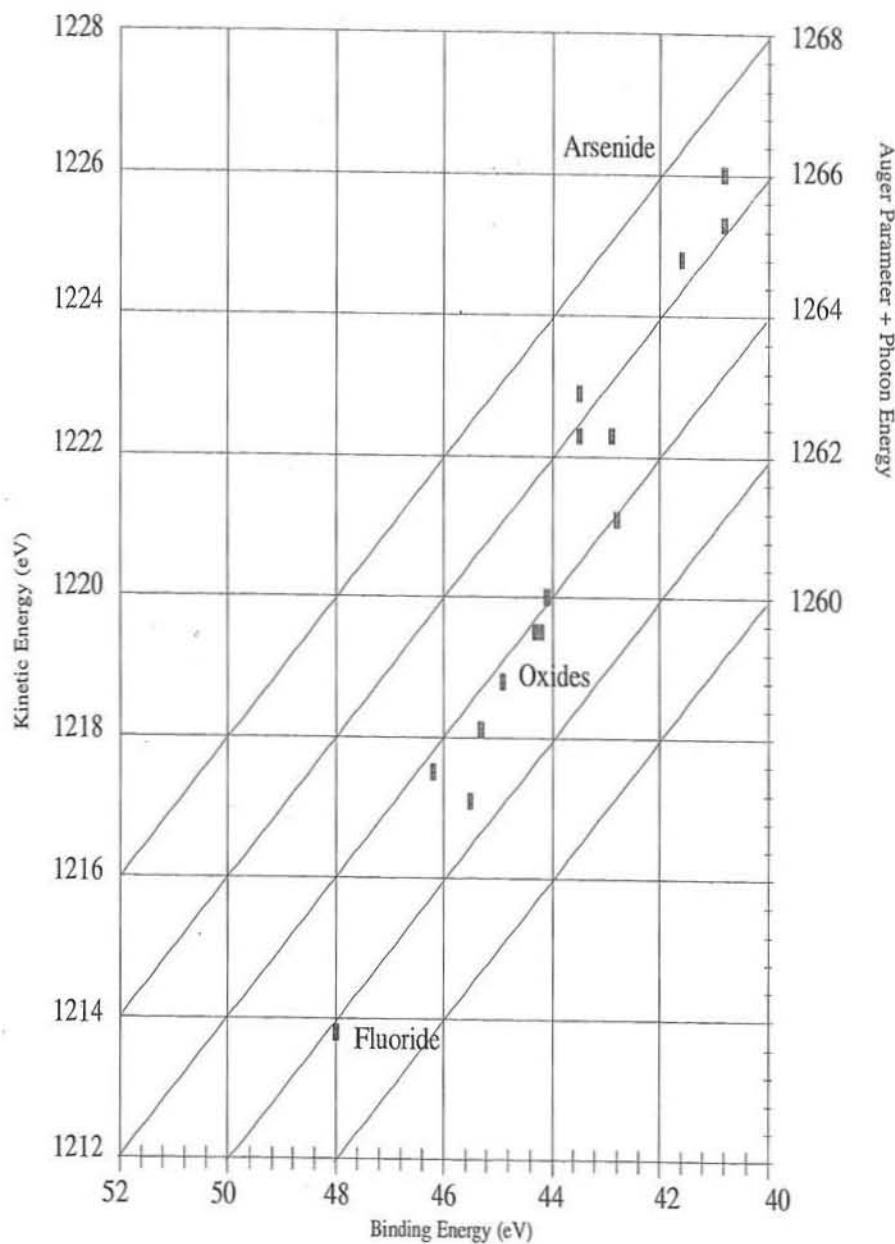
Compound	Cu 2p	Cu LMM
	Binding Energy (eV)	Kinetic Energy (eV)
Cu <sub>2</sub> Mo <sub>3</sub> O <sub>10</sub>	931.6	916.5
Cu <sub>2</sub> Se	931.9	917.6
CuAgSe	931.9	917.7
CuSe	932.0	918.4
CuS	932.2	917.9
CuBr <sub>2</sub>	932.3	916.9
Cu <sub>2</sub> S	932.5	917.4
CuCl	932.5	915.0
CuCl	932.5	915.6
Cu <sub>2</sub> O	932.5	916.2
Cu <sub>2</sub> O	932.5	916.2
Cu <sub>2</sub> O	932.5	916.6
Cu <sub>2</sub> O	932.5	917.2
Cu	932.6	918.6
Cu	932.6	918.7
Cu <sub>64</sub> Zn <sub>36</sub>	932.6	918.6
Cu	932.6	918.6
Cu	932.6	918.7
Cu	932.7	918.6
CuCN	933.1	914.5
CuC(CN) <sub>3</sub>	933.2	914.5
CuO	933.7	918.1
Cu <sub>3</sub> Mo <sub>2</sub> O <sub>9</sub>	934.1	916.6
CuMoO <sub>4</sub>	934.1	916.6
CuCr <sub>2</sub> O <sub>4</sub>	934.6	918.0
CuSiO <sub>3</sub>	934.9	915.2
CuCO <sub>3</sub>	935.0	916.3
Cu(OH) <sub>2</sub>	935.1	916.2
CuCl <sub>2</sub>	935.2	915.3
Cu(NO <sub>3</sub> ) <sub>2</sub>	935.5	915.3
CuSO <sub>4</sub>	935.5	915.6
CuF <sub>2</sub>	936.1	916.0
CuF <sub>2</sub>	936.8	914.4
CuF <sub>2</sub>	937.0	914.8



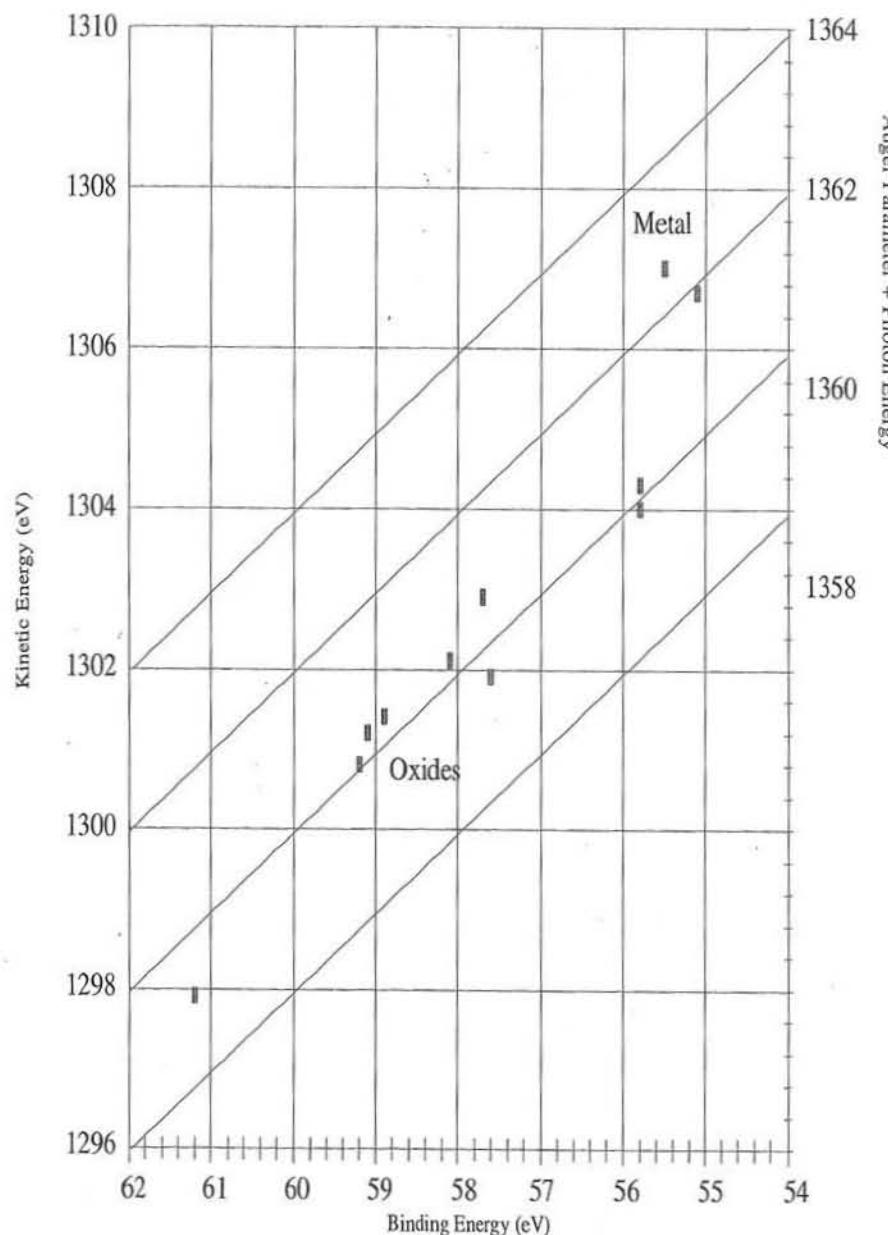
Compound	Zn 2p <sub>3/2</sub> Binding Energy (eV)	Zn LMM Kinetic Energy (eV)
Zn(acac) <sub>2</sub>	1021.4	987.7
Cu <sub>64</sub> Zn <sub>36</sub>	1021.6	992.7
ZnO	1021.75	988.5
Zn	1021.8	992.1
Zn	1021.89	992.1
ZnCl <sub>2</sub>	1021.9	989.4
Zn <sub>4</sub> Si <sub>2</sub> O <sub>7</sub> (OH) <sub>2</sub> · 2H <sub>2</sub> O	1021.96	987.3
ZnS	1022	989.7
ZnF <sub>2</sub>	1022.2	986.2
ZnO	1022.5	987.7
ZnF <sub>2</sub>	1022.8	986.7
ZnI <sub>2</sub>	1023	988.7
ZnBr <sub>2</sub>	1023.4	987.3



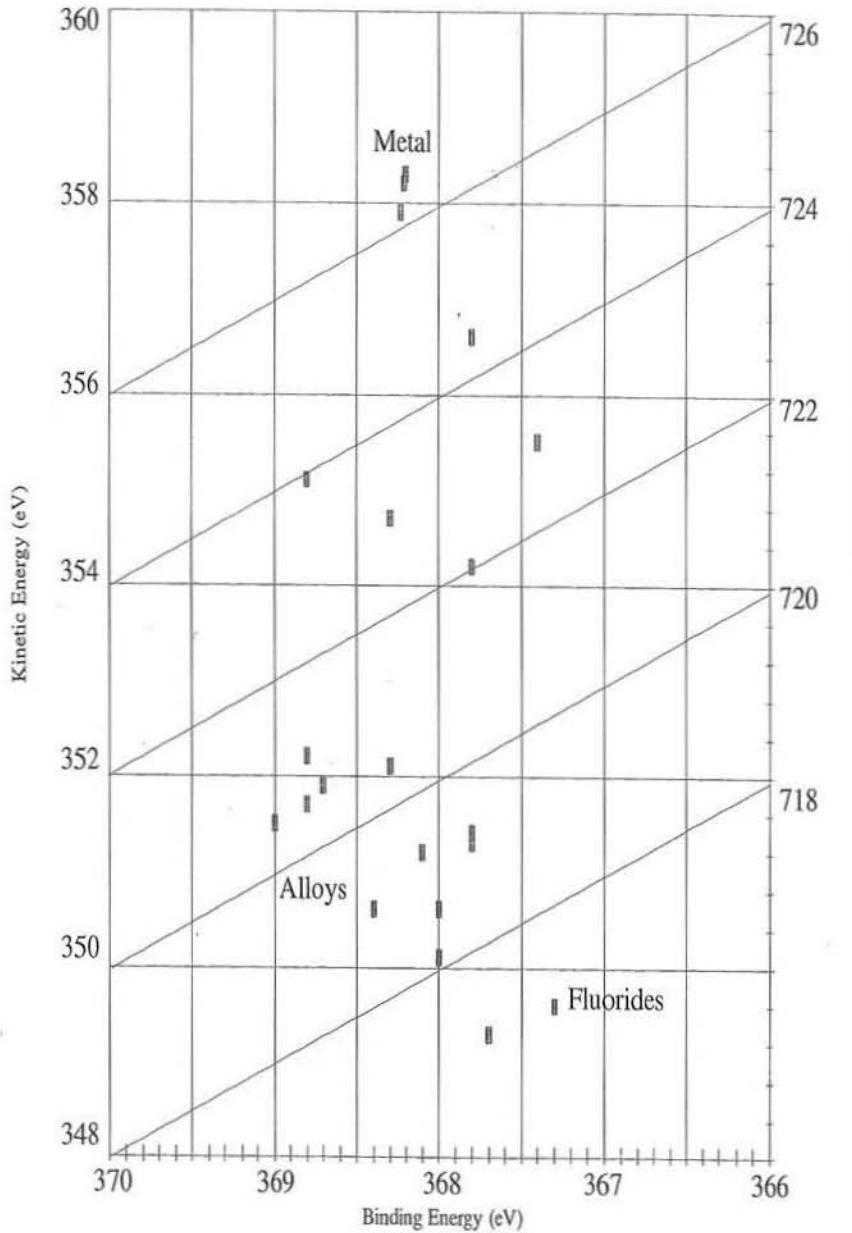
Compound	Arsenic	
	As 3d Binding Energy (eV)	As LMM Kinetic Energy (eV)
NbAs	40.8	1226.0
GaAs	40.8	1225.3
As	41.6	1224.8
Ph <sub>3</sub> As	42.8	1221.1
As <sub>2</sub> Se <sub>3</sub>	42.9	1222.3
AsI <sub>3</sub>	43.5	1222.9
MeAsI <sub>2</sub>	43.5	1222.3
Ph <sub>3</sub> AsS	44.1	1220.0
NaAsO <sub>2</sub>	44.2	1219.5
Ph <sub>3</sub> AsO	44.3	1219.5
As <sub>2</sub> O <sub>3</sub>	44.9	1218.8
AsBr <sub>3</sub>	45.3	1218.1
NaH <sub>2</sub> AsO <sub>4</sub>	45.5	1217.1
As <sub>2</sub> O <sub>5</sub>	46.2	1217.5
KAsF <sub>6</sub>	48.0	1213.8



Selenium		
Compound	Se 3d Binding Energy (eV)	Se LMM Kinetic Energy (eV)
Se	55.1	1306.7
Se	55.5	1307.0
Ph <sub>2</sub> Se	55.8	1304.0
Ph <sub>2</sub> Se <sub>2</sub>	55.8	1304.3
Ph <sub>2</sub> SeO	57.6	1301.9
Cl <sub>2</sub> SePh <sub>2</sub>	57.7	1302.9
I <sub>2</sub> SePh <sub>2</sub>	58.1	1302.1
SeO <sub>2</sub>	58.9	1301.4
Na <sub>2</sub> SeO <sub>3</sub>	59.1	1301.2
H <sub>2</sub> SeO <sub>3</sub>	59.2	1300.8
H <sub>2</sub> SeO <sub>4</sub>	61.2	1297.9

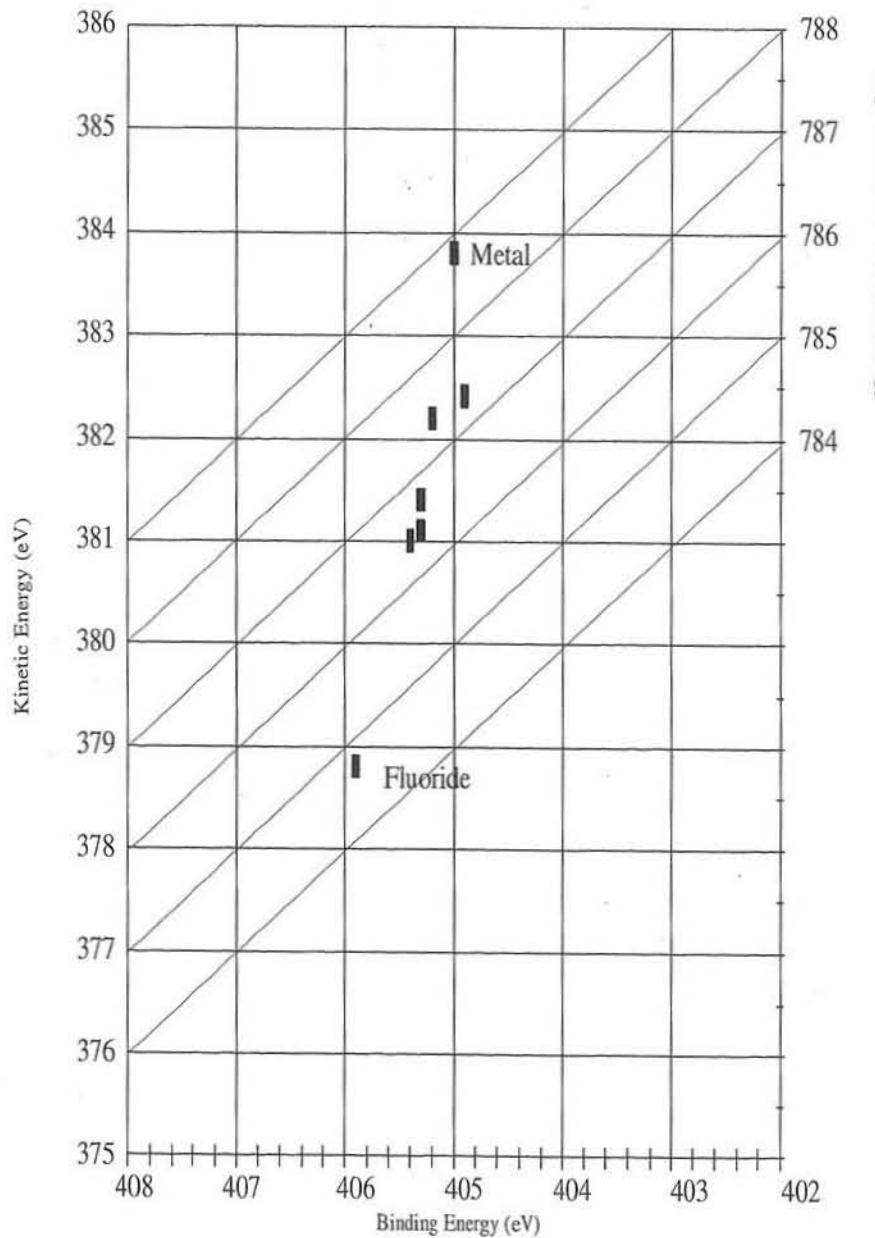


Silver		
Compound	Ag 3d Binding Energy (eV)	Ag MNN Kinetic Energy (eV)
AgF <sub>2</sub>	367.3	349.6
AgO	367.4	355.5
AgF	367.7	349.3
CuAgSe	367.8	351.3
Ag <sub>2</sub> Se	367.8	351.4
Ag <sub>2</sub> O	367.8	356.6
Ag <sub>2</sub> SO <sub>4</sub>	367.8	354.2
AgI	368.0	350.1
AgO	368.0	350.6
Ag <sub>2</sub> S	368.1	351.2
Ag	368.2	358.2
Ag	368.2	357.9
Mg <sub>21</sub> Ag <sub>79</sub>	368.3	352.1
Ag <sub>2</sub> SO <sub>4</sub>	368.3	354.7
Ag <sub>2</sub> O	368.4	350.6
Mg <sub>30</sub> Ag <sub>50</sub>	368.7	351.9
Al <sub>40</sub> Ag <sub>60</sub>	368.8	351.7
Mg <sub>97</sub> Ag <sub>3</sub>	368.8	352.2
AgOOCCF <sub>3</sub>	368.8	355.1
Al <sub>95</sub> Ag <sub>5</sub>	369.0	351.5



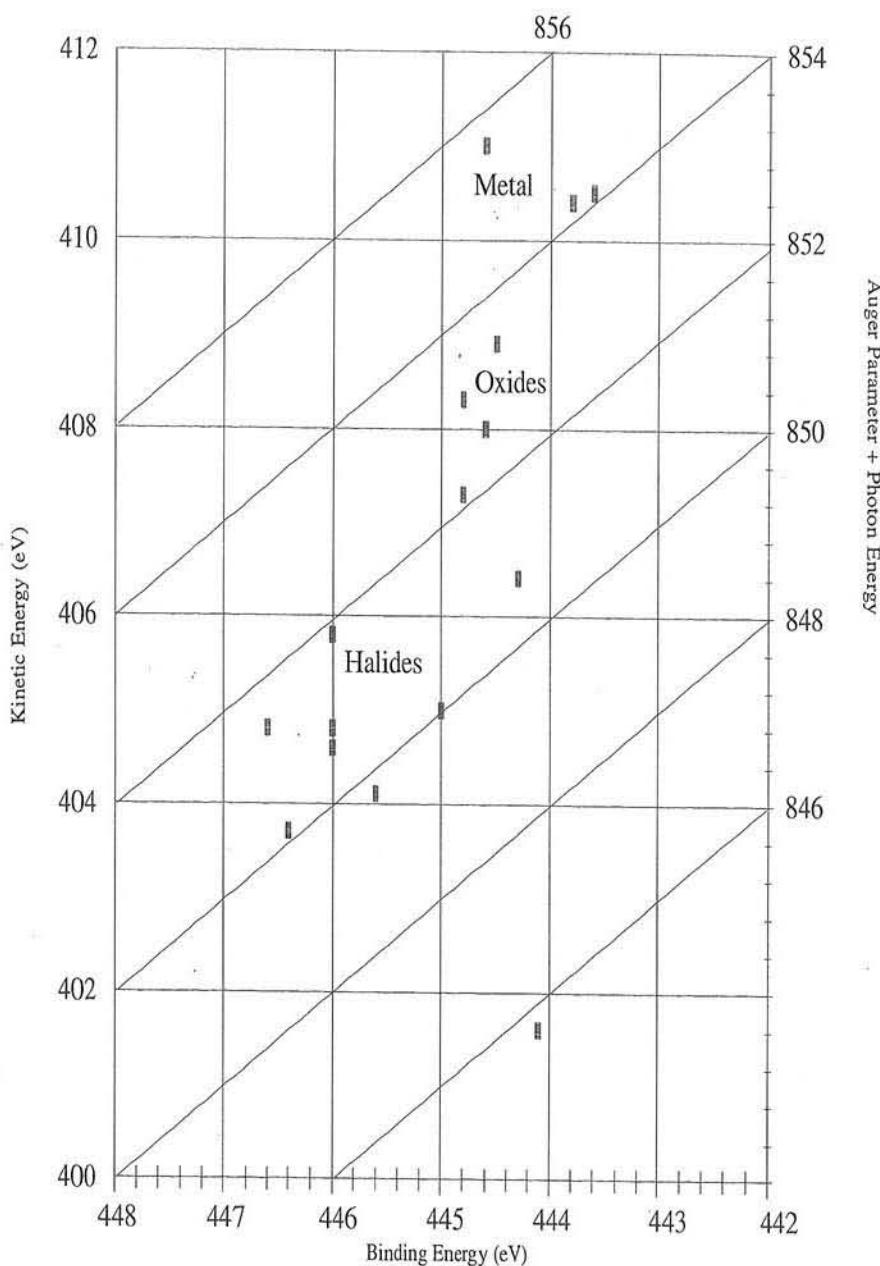
Auger Parameter + Photon Energy

Cadmium		
Compound	Cd 3d <sub>5/2</sub> Binding Energy (eV)	Cd MNN Kinetic Energy (eV)
CdTe	404.9	382.4
Cd	405.0	383.8
CdO	405.2	382.2
CdSe	405.3	381.4
CdS	405.3	381.1
CdI <sub>2</sub>	405.4	381.0
CdF <sub>2</sub>	405.9	378.8

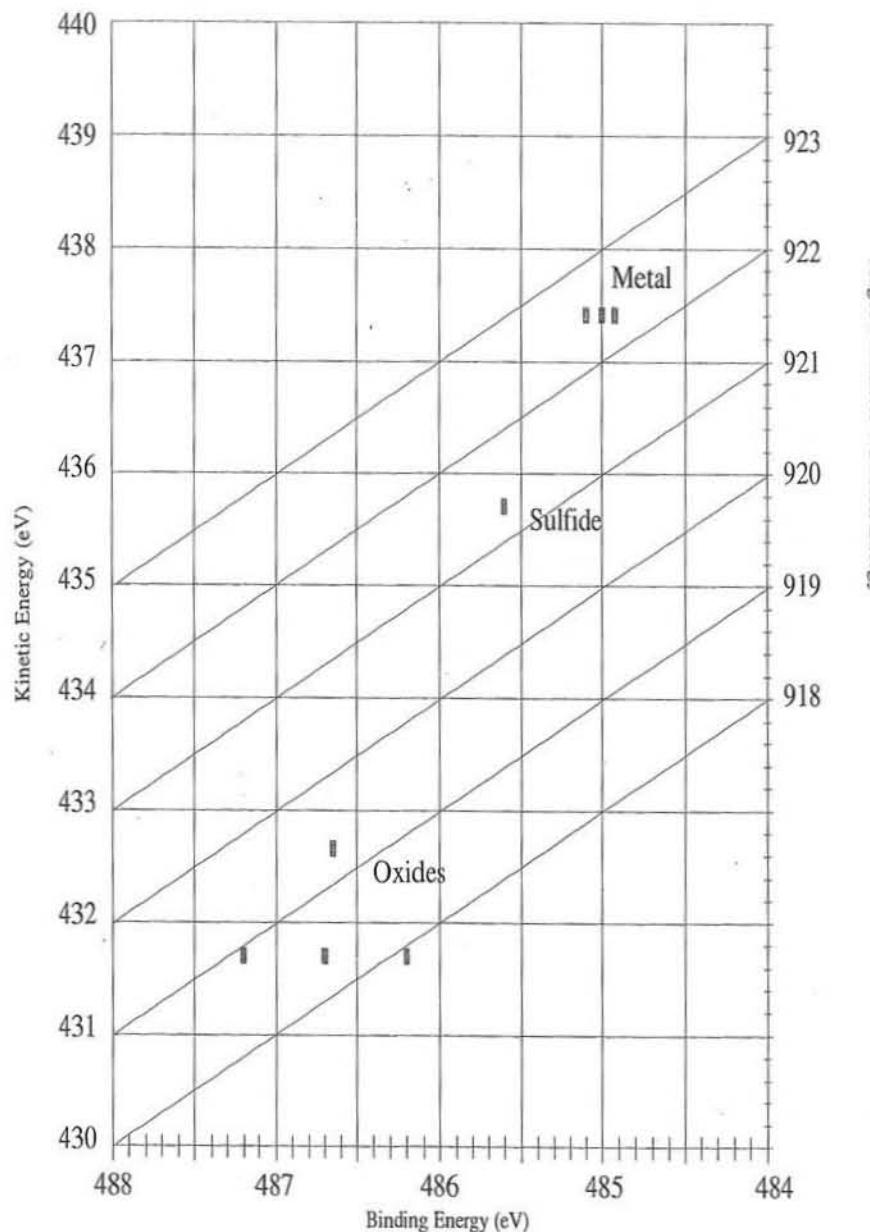


**Indium**

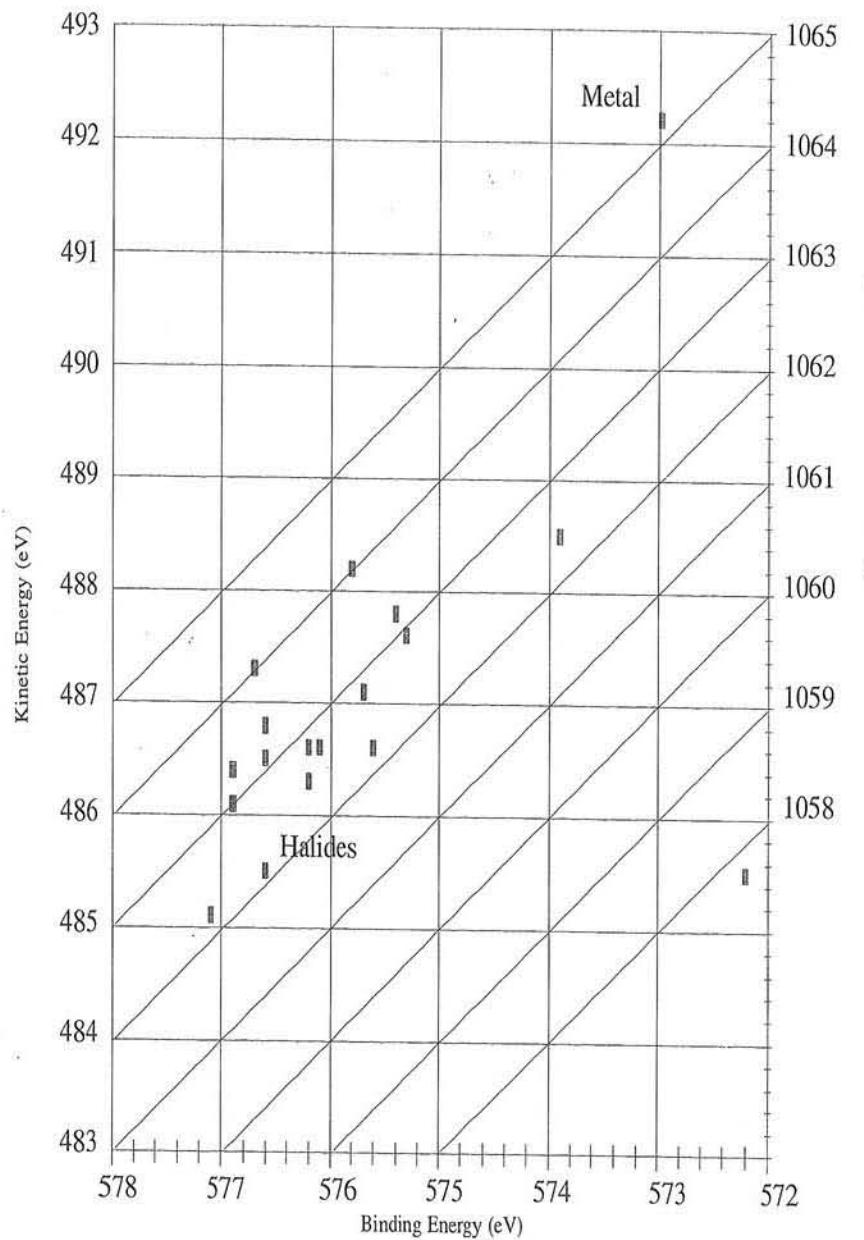
Compound	In 3d5/2 Binding Energy (eV)	In MNN Kinetic Energy (eV)
In <sub>95</sub> Sn <sub>5</sub>	443.6	410.5
In	443.8	410.4
InSb	444.1	401.6
In <sub>2</sub> O <sub>3</sub>	444.3	406.4
In <sub>2</sub> Te <sub>3</sub>	444.5	408.9
InP	444.6	408.0
InP	444.6	411.0
In <sub>2</sub> Se <sub>3</sub>	444.8	408.3
In <sub>2</sub> S <sub>3</sub>	444.8	407.3
In(OH) <sub>3</sub>	445.0	405.0
(NH <sub>4</sub> ) <sub>3</sub> InF <sub>6</sub>	445.6	404.1
InI <sub>3</sub>	446.0	405.8
InBr <sub>3</sub>	446.0	404.8
InCl <sub>3</sub>	446.0	404.6
InF <sub>3</sub>	446.4	403.7
InBr <sub>3</sub>	446.6	404.8



Tin		
Compound	Sn 3d <sub>5/2</sub> Binding Energy (eV)	Sn MNN Kinetic Energy (eV)
Sn	484.9	437.4
Sn	485.0	437.4
Sn	485.1	437.4
SnS	485.6	435.7
Na <sub>2</sub> SnO <sub>3</sub>	486.2	431.7
SnO <sub>2</sub>	486.7	432.7
Na <sub>2</sub> SnO <sub>3</sub>	486.7	431.7
Na <sub>2</sub> SnO <sub>3</sub>	487.2	431.7
NaSnF <sub>3</sub>	487.4	430.8



Tellurium		
Compound	Te 3d <sub>5/2</sub> Binding Energy (eV)	Te MNN Kinetic Energy (eV)
Na <sub>2</sub> Te	572.2	485.5
Te	573.0	492.2
Ph <sub>2</sub> Te <sub>2</sub>	573.9	488.5
I <sub>2</sub> TeEt <sub>2</sub>	575.3	487.6
I <sub>2</sub> TePh <sub>2</sub>	575.4	487.8
I <sub>2</sub> TeMe <sub>2</sub>	575.6	486.6
TeO <sub>2</sub>	575.7	487.1
I <sub>3</sub> TePh	575.8	488.2
p-tolylTeOOH	576.1	486.6
Cl <sub>2</sub> TePh <sub>2</sub>	576.2	486.3
Br <sub>2</sub> TePh <sub>2</sub>	576.2	486.6
TeO <sub>3</sub>	576.6	485.5
Br <sub>3</sub> TePh	576.6	486.8
Br <sub>3</sub> TeBu	576.6	486.5
TeBr <sub>2</sub>	576.7	487.3
TeCl <sub>4</sub>	576.9	486.1
(NH <sub>4</sub> ) <sub>2</sub> TeCl <sub>6</sub>	576.9	486.4
Te(OH) <sub>6</sub>	577.1	485.1



Auger Parameter + Photon Energy

## Appendix B. Chemical States Tables

This compilation of all the elements, listed alphabetically, provides specific binding energies of various compounds and pure elements, and a reference in abbreviated notation. When Auger lines are listed, they are in kinetic energy. For compounds with more than one chemical state, an asterisk denotes the atom whose binding energy is listed. The references are expanded in Appendix C. Any listing with a  $\Phi$  refers to the work contained in this handbook.

This appendix, most of which was compiled by Dr. Charles Wagner for Perkin-Elmer, is part of the chemical state identification algorithm of the PHI software and is also the basis for the XPS database SRD-20 of the National Institute for Standards and Technology (NIST). Further references may also be found in the journal Surface Science Spectra published by the American Vacuum Society.

### Ag 3d

Ag	368.3	$\Phi$	Ag <sub>2</sub> Se	351.4	RRD78
Ag	368.2	Asam76	Ag <sub>2</sub> S	351.2	RRD78
Ag	368.2	BiSw80	AgI	350.1	GaWi77
Ag	368.1	BiSw80	AgF	349.3	GaWi77
Ag	368.2	BiSw80	AgF <sub>2</sub>	349.6	GaWi77
Ag	368.2	JHBK73	Ag <sub>2</sub> O	356.6	Scho73
Ag	368.2	NyMa80	Ag <sub>2</sub> O	350.6	RRD78, GaWi77
Ag	368.2	HGW75, Scho73, WRDM79, GaWi77, SFS77, Wagn75	AgO	355.5	WRDM79
Ag	368.2	RRD78, Scho72	Ag <sub>2</sub> SO <sub>4</sub>	354.2	Wagn75
Ag <sub>95</sub> Sn <sub>5</sub>	368.0	HSBS81	AgOOCCF <sub>3</sub>	355.1	Wagn75
Al <sub>40</sub> Ag <sub>60</sub>	368.8	WeAn80			
Al <sub>95</sub> Ag <sub>5</sub>	369.0	WeAn80	Al 2p		
Mg <sub>21</sub> Ag <sub>79</sub>	368.3	WeAn80	Al	72.9	$\Phi$
Mg <sub>30</sub> Ag <sub>50</sub>	368.7	WeAn80	Al <sub>2</sub> O <sub>3</sub> , sapphire	74.4	$\Phi$
Mg <sub>97</sub> Ag <sub>3</sub>	368.8	WeAn80	Al	72.8	LMKJ75, Tayl82, WPHK82, WRDM79, WaTa80
Ag <sub>2</sub> Yb	368.8	WWC78			
CuAgSe	367.8	RRD78	AlB <sub>2</sub>	71.9	MECC73
Ag <sub>2</sub> Se	367.8	RRD78	AlAs	73.6	Tayl82
Ag <sub>2</sub> S	368.1	RRD78	AlGaAs	73.6	Tayl82
AgI	368.0	GaWi77	Fe <sub>3</sub> Al	73.4	ShTr75
AgF	367.7	GaWi77	LiAlH <sub>4</sub>	75.6	MSC73
AgF <sub>2</sub>	367.3	GaWi77	AlN	74.4	MSC73
Ag <sub>2</sub> O	367.8	HGW75, GaWi77, Scho73	Al <sub>2</sub> S <sub>3</sub>	74.6	MSC73
Ag <sub>2</sub> O	368.4	RRD78	AlI <sub>3</sub>	74.6	MSC73
AgO	367.4	HGW75, GaWi77, Scho73	AlBr <sub>3</sub>	75.2	MSC73
AgO	368.0	WRDM79	AlCl <sub>3</sub>	74.7	MSC73
Ag <sub>2</sub> CO <sub>3</sub>	367.5	HGW75	AlF <sub>3</sub>	76.3	MSC73
Ag <sub>2</sub> SO <sub>4</sub>	367.8	TMR80	Al <sub>2</sub> (MoO <sub>4</sub> ) <sub>3</sub>	74.2	PCLH76
Ag <sub>2</sub> SO <sub>4</sub>	368.3	Wagn75	Al <sub>2</sub> (WO <sub>4</sub> ) <sub>3</sub>	74.3	NgHe76
AgOOCCF <sub>3</sub>	368.8	Wagn75	CoAl <sub>2</sub> O <sub>4</sub>	73.6	PCLH76
Ag(OAc)	368.4	HHDD81	MgAl <sub>2</sub> O <sub>4</sub>	74.7	HNUW78
Ag(3-Cl-pyridin) <sub>2</sub> NO <sub>3</sub>	368.6	SmWa77	NiAl <sub>2</sub> O <sub>4</sub>	74.2	LFWS79, NgHe76
			Al <sub>2</sub> O <sub>3</sub>	74.3	Nefe82, MSC73, NSLS77
			Al <sub>2</sub> O <sub>3</sub>	74.7	KIHe83, NGDS75
Ag MNN					
Ag	357.9	WRDM79	Al <sub>2</sub> O <sub>3</sub> , sapphire	74.2	Tayl82, WPHK82
Ag	358.2	Wagn75	Al <sub>2</sub> O <sub>3</sub> , alpha	73.9	WPHK82
Ag	351.9	RRD 78, PWA 79	Al <sub>2</sub> O <sub>3</sub> , gamma	73.7	WPHK82
Ag	351.6	GaWi77	Al <sub>2</sub> O <sub>3</sub> , gamma	74.0	Ban83
Ag	358.3	Scho73, FKW77	Al <sub>2</sub> O <sub>3</sub> , gamma	74.3	NgHe76
Al <sub>4</sub> O <sub>4</sub> Ag <sub>56</sub>	351.7	WeAn80	AlO <sub>2</sub> H, boehmite	74.2	Tayl82, WPHK82
Al <sub>95</sub> Ag <sub>5</sub>	351.5	WeAn80	Al(OH) <sub>3</sub> , bayerite	74.2	Tayl82, WPHK82
Mg <sub>21</sub> Ag <sub>79</sub>	352.1	WeAn80	Al(OH) <sub>3</sub> , gibbsite	74.0	WPHK82
Mg <sub>30</sub> Ag <sub>50</sub>	351.9	WeAn80	Al <sub>2</sub> SiO <sub>5</sub> , kyanite	74.7	AnSw74
Mg <sub>97</sub> Ag <sub>3</sub>	352.2	WeAn80	Al <sub>2</sub> SiO <sub>5</sub> , mullite	74.8	AnSw74
CuAgSe	351.3	RRD78	Al <sub>2</sub> SiO <sub>5</sub> , sillimanite	74.6	AnSw74, WPHK82
			Albite, NaAlSi <sub>3</sub> O <sub>8</sub>	74.3	WPHK82

Bentonite	75.0	Barr83	As <sub>4</sub> S <sub>4</sub>	43.1	BWWI76
Kaolinite	74.6	Barr83, WPHK82	As <sub>2</sub> S <sub>3</sub>	43.4	BWWI76
Mica, muscovite	74.3	WPHK82	As <sub>2</sub> S <sub>5</sub>	44.4	SMAV72
Natrolite	74.3	WPHK82	AsI <sub>3</sub>	43.5	BWWI76
Pyrophyllite	74.7	WPHK82	AsBr <sub>3</sub>	45.3	BWWI76
Spodumene	74.3	WPHK82	As <sub>2</sub> O <sub>3</sub>	44.9	LPGC77, MINN78, Tayl82, WRDM79
H Zeolon	74.8	WPHK82	As <sub>2</sub> O <sub>5</sub>	46.2	Bert81, BWWI76, MINN78, SMAV72
Hydroxysodalite	75.0	WPHK82	KH <sub>2</sub> AsO <sub>4</sub>	46.7	SMAV72
Mol Sieve A	73.6	WPHK82, Barr83	NaH <sub>2</sub> AsO <sub>4</sub>	45.5	WRDM79
Al(acac) <sub>3</sub>	72.9	MSC73	NaAsO <sub>2</sub>	44.2	Tayl82, WRDM79
<b>Al KLL</b>					
Al	1393.3	WPHK82, WaTa80	K <sub>3</sub> AsO <sub>4</sub>	44.4	SMAV72
AlAs	1391.2	Tayl82	Na <sub>3</sub> AsO <sub>4</sub>	44.9	SMAV72
AlN	1389.0	TaRa81	Na <sub>4</sub> As <sub>2</sub> O <sub>7</sub>	45.4	SMAV72
Al <sub>2</sub> O <sub>3</sub> , sapphire	1387.8	Tayl82, WPHK82	KAsF <sub>6</sub>	48.0	SMAV72, WRDM79
Al <sub>2</sub> O <sub>3</sub> , alpha	1388.2	WPHK82	LiAsF <sub>6</sub>	49.4	SMAV72
Al <sub>2</sub> O <sub>3</sub> , gamma	1387.8	WPHK82	Ph <sub>3</sub> As	42.8	HVV79, SMAV72
AlOOH	1387.6	WPHK82, Tayl82	Ph <sub>3</sub> AsS	44.1	BWWI76, HVV79
Al(OH) <sub>3</sub> , bayerite	1387.7	WPHK82, Tayl82	Ph <sub>3</sub> AsO	44.3	BWWI76, SMAV72, HVV79
Al(OH) <sub>3</sub> , gibbsite	1387.4	WPHK82	Ph <sub>3</sub> As(OH) <sub>2</sub>	44.5	SMAV72
Al <sub>2</sub> SiO <sub>5</sub> , sillimanite	1386.9	WPHK82	MeAsI <sub>2</sub>	43.5	BWWI76
Albite, NaAlSi <sub>3</sub> O <sub>8</sub>	1386.5	WPHK82	Ph <sub>4</sub> AsI	44.6	HVV79
Kaolinite	1386.7	WPHK82	Ph <sub>4</sub> AsBr	44.6	HVV79, SMAV72
Mica, muscovite	1387.1	WPHK82	<b>As LMM</b>		
Natrolite	1386.5	WPHK82	As	1224.8	Wagn75, BWWI76
Pyrophyllite	1386.8	WPHK82	NbAs	1226.0	BWWI76
Spodumene	1387.1	WPHK82	GaAs	1225.3	Tayl82, WRDM79
H Zeolon	1385.5	WPHK82	As <sub>2</sub> Te <sub>3</sub>	1225.0	BWWI76
Hydroxysodalite	1386.4	WPHK82	As <sub>2</sub> Se <sub>3</sub>	1223.3	BWWI76
Mol Sieve	1386.9	WPHK82	As <sub>2</sub> S <sub>3</sub>	1222.1	BWWI76
<b>Ar 2p</b>					
Ar in Si	241.9	Φ	AsI <sub>3</sub>	1222.9	BWWI76
Ar in Ag	241.2	CiHa74	AsBr <sub>3</sub>	1218.1	BWWI76
Ar in Ag	241.9	KiWi75	As <sub>2</sub> O <sub>3</sub>	1218.8	Tayl82, WRDM79, BWWI76
Ar in Au	240.3	CiHa74	As <sub>2</sub> O <sub>5</sub>	1217.5	BWWI76
Ar in Au	240.7	KiWi75	NaH <sub>2</sub> AsO <sub>4</sub>	1217.1	WRDM79
Ar in Cu	241.1	CiHa74	NaAsO <sub>2</sub>	1219.5	Tayl82, WRDM79
Ar in Pt	240.4	KiWi75	K <sub>2</sub> AsF <sub>6</sub>	1213.8	WRDM79
Ar in graphite	241.8	KiWi75	Ph <sub>3</sub> As	1221.1	BWWI76
Ar in graphite	241.5	WRDM79	Ph <sub>3</sub> AsS	1220.0	BWWI76
<b>As 3d</b>					
As	41.6	Φ	Ph <sub>3</sub> AsO	1219.5	BWWI76
As	41.6	Bert81, BWWI76, MINN78, SMAV72, UeOd81	MeAsI <sub>2</sub>	1222.3	BWWI76
NbAs	40.8	BWWI76	<b>Au 4f</b>		
AlAs	41.0	Tayl82	Au	84.0	Φ
AlGaAs	41.0	Tayl82	Au	84.1	Asam76
GaAs	40.8	LPMK74	Au	84.0	BiSw80
GaAs	40.9	GGVL79, WRDM79, Tayl82, MINN78, IMNN79	Au	84.0	BiSw80
InAs	40.6	LPMK74	Au	83.9	BiSw80
As <sub>2</sub> Se <sub>3</sub>	42.9	BWWI76, UeOd82	Au	84.1	PEJ 82
			AuSn	84.2	ALMP82
			AuSn <sub>4</sub>	84.5	FHPW73
			YbAu <sub>2</sub>	85.1	FHPW73
			ClAuPh <sub>3</sub> P	84.6	WWC 78
				85.4	BMCK77, VVSW77

ClAu(Ph <sub>3</sub> P) <sub>2</sub>	85.4	BMCK77	Ba 3d <sub>5/2</sub>	Ba	780.6	Φ
Cl <sub>3</sub> AuPh <sub>3</sub> P	87.3	BMCK77		Ba	779.3	VaVe80
(Ph <sub>3</sub> P)AuNO <sub>3</sub>	85.4	BMCK77		BaS	779.8	SiWo80
ClAu(Ph <sub>3</sub> As)	85.2	VVSW77		BaO	779.9	WRDM79
(-AuSPt <sub>2</sub> S-) <sub>2</sub>	84.8	VVSW77		BaO	779.6	SiWo80
(-AuCH <sub>2</sub> PEt <sub>2</sub> CH <sub>2</sub> -) <sub>2</sub>	84.0	VVSW77		BaO	779.1	VaVe80
				Ba(NO <sub>3</sub> ) <sub>2</sub>	780.7	CLSW83
				BaCO <sub>3</sub>	779.9	CLSW83
				BaSO <sub>4</sub>	780.8	Wagn77
				BaSO <sub>4</sub>	780.4	CLSW83
				BaSO <sub>4</sub>	779.9	SiWo80
				BaCrO <sub>4</sub>	778.9	ACHT73
				BaMoO <sub>4</sub>	779.1	NFS82
				BaRh <sub>2</sub> O <sub>4</sub>	779.6	NFS82
			Ba MNN	Ba	602.0	VaVe80
				BaO	597.5	WRDM79
				BaO	598.4	VaVe80
				BaSO <sub>4</sub>	596.1	Wagn77
			Be 1s	Be	111.8	Φ
				Be	111.7	HJGN70, SMKM77, WRDM79
				BeO	113.8	HJGN70, KOK83, NFS82
				BeMoO <sub>4</sub>	113.7	NFS82
				BeRh <sub>2</sub> O <sub>4</sub>	113.8	NFS82
				BeF <sub>2</sub>	115.3	NKBP73
				BeF <sub>2</sub>	116.1	HJGN70
				NaBeF <sub>3</sub>	115.3	NKBP73
				Na <sub>2</sub> BeF <sub>4</sub>	114.7	NKBP73
			Bi 4f	Bi	157.0	Φ
				Bi	156.9	SFS77
				Bi	157.0	LKMP73
				Bi	157.0	WRDM79, MSV73
				Bi <sub>2</sub> S <sub>3</sub>	158.9	MSV73
				BiI <sub>3</sub>	159.3	MSV73
				BiF <sub>3</sub>	160.8	MSV73
				Bi <sub>2</sub> O <sub>3</sub>	158.8	NGDS75
				Bi <sub>2</sub> O <sub>3</sub>	159.3	MSV73
				Bi <sub>2</sub> O <sub>3</sub>	159.8	DSBG82
				BiOCl	159.9	MSV73
				NaBiO <sub>3</sub>	159.1	MSV73
				Bi <sub>2</sub> MoO <sub>6</sub>	158.3	MaWo75
				Bi <sub>2</sub> Ti <sub>2</sub> O <sub>7</sub>	159.7	MSV73
				(BiO) <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	159.6	MSV73
				Bi <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · H <sub>2</sub> O	161.2	MSV73
			Br 3d	KBr	68.8	Φ
				CsBr	68.1	MVS73
				CsBr	69.6	Shlq78



RbBr	68.4	MVS73	Cr(CO) <sub>6</sub>	287.9	BCGH72, BCHM72,
KBr	68.8	MVS73, WaTa80	Co(CO) <sub>3</sub> NO	288.2	KTWY76, PFD73
NaBr	68.8	MVS73, ShIq78	Fe(CO) <sub>3</sub>	288.0	BCGH72
LiBr	69.2	MVS73	Fe(CO) <sub>3</sub> (NO) <sub>2</sub>	288.2	BCGH72
CdBr <sub>2</sub>	69.2	SATD73	Mn <sub>2</sub> (CO) <sub>10</sub>	287.5	VWVB77
CuBr <sub>2</sub>	68.9	VWHS81	Ni(CO) <sub>4</sub>	288.2	BCGH72
HgBr <sub>2</sub>	69.0	SATD73	(Mn(CO) <sub>4</sub> Br) <sub>2</sub>	287.6	VWVB77
PbBr <sub>2</sub>	68.7	Nefe82	BrMn(CO) <sub>5</sub>	288.0	VWVB77
ZnBr <sub>2</sub>	70.0	SATD73	Ag <sub>2</sub> CO <sub>3</sub>	288.4	HGW 75
Co(NH <sub>3</sub> ) <sub>6</sub> SbBr <sub>6</sub>	68.9	Tric74	BaCO <sub>3</sub>	289.4	CLSW83
Ni(NH <sub>3</sub> ) <sub>6</sub> Br <sub>2</sub>	68.7	NZB 78	CaCO <sub>3</sub>	289.6	CLSW83
Pt(NH <sub>3</sub> ) <sub>4</sub> Br <sub>2</sub>	68.4	SNMK78	CdCO <sub>3</sub>	289.3	HGW 75
K <sub>2</sub> PtBr <sub>4</sub>	69.3	SNMK78	Li <sub>2</sub> CO <sub>3</sub>	289.8	CSFG79
K <sub>2</sub> PtBr <sub>6</sub>	69.2	SNMK78	Na <sub>2</sub> CO <sub>3</sub>	289.4	GHHL70, HHDD81
Cs <sub>3</sub> Sb <sub>2</sub> Br <sub>9</sub>	70.8	Tric74	NaHCO <sub>3</sub>	290.0	GHHL70
Rb <sub>3</sub> Sb <sub>2</sub> Br <sub>9</sub>	70.1	Tric74	SrCO <sub>3</sub>	289.5	CLSW83
Bromanil	70.1	OYK74	CS <sub>2</sub>	287.0	GHHL70
Ph <sub>4</sub> AsBr	66.7	HVV79	CO <sub>2</sub>	291.9	GHHL70
Ph <sub>4</sub> SbBr	68.0	HVV79	CCl <sub>4</sub>	292.4	GHHL70
(Me <sub>4</sub> N) <sub>2</sub> ZnBr <sub>4</sub>	67.8	EMGK74	COF <sub>2</sub>	293.9	GHHL70
(Et <sub>4</sub> N) <sub>2</sub> MnBr <sub>4</sub>	67.9	EMGK74	CF <sub>4</sub>	296.7	GHHL70
(Et <sub>4</sub> N) <sub>2</sub> NiBr <sub>4</sub>	68.9	EMGK74	Cyclohexane	285.2	GHHL70
H <sub>3</sub> POBBBr <sub>3</sub>	69.3	HVV79	Benzene	284.7	GHHL70, LaFo76, CKAM72
H <sub>3</sub> PBBr <sub>3</sub>	69.6	HVV79	C <sub>6</sub> H <sub>5</sub> C*H <sub>3</sub>	284.7	CKM71
Br <sub>2</sub> Pt(CH <sub>3</sub> CONH) <sub>4</sub>	68.7	NeSa78	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> (C*CH <sub>3</sub> )	285.1	CKM71
<b>Br LMM</b>					
LiBr	1389.2	Wagn78	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> (C*-H)	285.0	CKM71
NaBr	1388.3	Wagn78	Fe(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	284.5	BCDH73
KBr	1388.0	WaTa80	Cr(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub>	284.4	KTWY76
KBrO <sub>3</sub>	1384.4	Wagn78	CH <sub>3</sub> C*H <sub>2</sub> OH	286.3	GHHL70
Cl <sub>6</sub> H <sub>33</sub> Me <sub>3</sub> NBr	1390.1	Wagn78	CH <sub>3</sub> COOC*H <sub>2</sub> CH <sub>3</sub>	286.9	GHHL70
<b>C 1s</b>					
Graphite	284.5	Φ	C <sub>6</sub> F <sub>6</sub>	289.5	CKAM72
Graphite	284.3	JHBK73	Inositol	286.7	GHHL70
Cr <sub>3</sub> C <sub>2</sub>	282.8	RHJF69	Hydroquinone	286.4	OYK74
Fe <sub>3</sub> C	283.9	ShTr75	(C*HCOH) <sub>3</sub>	284.8	GHHL70
HfC	280.8	RHJF69	(CHC*OH) <sub>3</sub>	286.6	GHHL70
Mo <sub>2</sub> C	282.7	RHJF69	(CH <sub>3</sub> C*H <sub>2</sub> ) <sub>2</sub> O	286.5	GHHL70, ClTh78
NbC	281.9	RHJF69	HCHO	287.7	GHHL70
Ni <sub>3</sub> C	283.9	SiLe78	(CH <sub>3</sub> C*HO) <sub>3</sub>	287.6	GHHL70
TaC	281.9	RHJF69	CH <sub>3</sub> C*OCH <sub>3</sub>	287.9	GHHL70
TiC	281.6	RHJF69, IKIM73	CF <sub>3</sub> C*OCH <sub>3</sub>	288.5	GHHL70
VC	282.2	RHJF69	C*F <sub>3</sub> COCH <sub>3</sub>	292.6	GHHL70
WC	282.8	RHJF69, CoRa76	(CO) <sub>6</sub>	288.3	GHHL70
ZrC	281.1	RHJF69	CH <sub>3</sub> C*OOH	289.3	GHHL70
KCN	286.1	Vann76	CH <sub>3</sub> C*OO <sup>-</sup>	288.2	HHDD81
NaCN	286.2	Vann76	CH <sub>3</sub> C*OONa	288.8	GHHL70
K <sub>3</sub> Co(CN) <sub>6</sub>	285.9	Vann76	CH <sub>3</sub> C*OONa	288.3	HHDD81
K <sub>3</sub> Cr(CN) <sub>6</sub>	283.9	Vann76, ZeHa71	CH <sub>3</sub> C*OOAg	288.3	HHDD81
K <sub>3</sub> Fe(CN) <sub>6</sub>	283.9	Vann76, ZeHa71	HOOCCOOH	289.9	GHHL70
K <sub>4</sub> Fe(CN) <sub>6</sub>	283.5	Vann76	(COONa) <sub>2</sub>	289.0	GHHL70
K <sub>3</sub> Mn(CN) <sub>6</sub>	284.0	Vann76	CF <sub>3</sub> C*OOEt	290.4	GHHL70
Na <sub>4</sub> Mn(CN) <sub>6</sub>	284.0	Vann76	C*F <sub>3</sub> COOEt	292.9	GHHL70
K <sub>4</sub> V(CN) <sub>6</sub>	285.5	Vann76	Cl <sub>3</sub> C*COONa	289.5	GHHL70
			Cl <sub>3</sub> CC*OONa	288.3	GHHL70
			F <sub>3</sub> C*COONa	292.1	GHHL70
			F <sub>3</sub> CC*OONa	288.9	GHHL70
			p-Benzoquinone	287.4	OYK74

Cr(acac) <sub>3</sub>	286.0	ZeHa71	PVA (-CH <sub>2</sub> C*HOH-) <sub>n</sub>	286.1	PRCV77
CH <sub>3</sub> C*H <sub>2</sub> OOCOC <sub>1</sub>	287.1	GHHL70	Cellulose	286.2	CDW81
EtOC*OCl	290.8	GHHL70	PEO (-CH <sub>2</sub> C*H <sub>2</sub> O-) <sub>n</sub>	286.1	CDW81
(PhO) <sub>2</sub> CO	290.7	ClTh78	poly (-CH <sub>2</sub> CH <sub>2</sub> C=O-) <sub>n</sub>	287.4	CDW81
HC*(OCH <sub>3</sub> ) <sub>3</sub>	289.7	GHHL70	C <sub>6</sub> H <sub>4</sub> (C*OOH) <sub>2</sub>	288.9	CDW81
HCOONH <sub>4</sub>	288.4	GHHL70	HOOC*(CH <sub>2</sub> ) <sub>4</sub> C*OOH	288.9	CDW81
OC*(OCH <sub>3</sub> ) <sub>2</sub>	291.2	GHHL70	Sodium Stearate	288.3	CDW81
O(C*H <sub>2</sub> COOH) <sub>2</sub>	286.7	GHHL70	Mylar Polyester C*-H	284.85	JFM
O(CH <sub>2</sub> C*OOH) <sub>2</sub>	289.5	GHHL70	Mylar Polyester C*-O	286.3	CDW81
CH <sub>3</sub> C*H <sub>2</sub> Cl	286.1	GHHL70	Mylar Polyester C*O <sub>2</sub>	288.7	CDW81
CH <sub>2</sub> Br <sub>2</sub>	287.1	GHHL70	Polycarbonate-OC*O <sub>2</sub> -	290.4	CDW81
CH <sub>2</sub> Cl <sub>2</sub>	287.8	GHHL70	Teflon (-CF <sub>2</sub> CF <sub>2</sub> -) <sub>n</sub>	292.2	CFK73
HCF <sub>3</sub>	294.7	GHHL70	(-C*FHCF <sub>2</sub> -) <sub>n</sub>	289.3	CFK73
HCCl <sub>3</sub>	289.6	GHHL70	(-CFHC*F <sub>2</sub> -) <sub>n</sub>	291.6	CFK73
C <sub>6</sub> H <sub>5</sub> Cl (C*Cl)	287.1	CKM71	(-CFHCFH-) <sub>n</sub>	288.4	CFK73
C <sub>6</sub> H <sub>5</sub> Cl(C*H)	285.7	CKM71	(-C*H <sub>2</sub> CF <sub>2</sub> -)	286.3	CFK73
C <sub>6</sub> H <sub>5</sub> Br	285.1	LaFo76	(-CH <sub>2</sub> C*F <sub>2</sub> -) <sub>n</sub>	290.8	CFK73
C <sub>6</sub> H <sub>5</sub> F(C*F)	287.8	CKM71	(-C*H <sub>2</sub> CFH-) <sub>n</sub>	285.9	CFK73
C <sub>6</sub> H <sub>5</sub> F(C*H)	285.6	CKM71	(-CH <sub>2</sub> C*FH-) <sub>n</sub>	288.0	CFK73
C <sub>6</sub> HCl <sub>5</sub>	286.1	CKAM75	PVC (-C*H <sub>2</sub> CHCl-)	284.9	PRCV77
C <sub>6</sub> HF <sub>5</sub> (C*H)	286.9	CKAM72	PVC (-CH <sub>2</sub> C*HCl-)	286.5	PRCV77
C <sub>6</sub> HF <sub>5</sub> (C*F)	289.2	CKAM72			
C <sub>6</sub> F <sub>6</sub>	288.7	GHHL70	<b>Ca 2p</b>		
Cl <sub>2</sub> FCCFCI <sub>2</sub>	291.7	GHHL70	Ca	346.3	Φ
ClF <sub>2</sub> C*FCFCI <sub>2</sub>	292.9	GHHL70	CaCO <sub>3</sub>	346.6	Φ
C*H <sub>3</sub> CN	286.3	BCGH73	Ca	345.9	VaVe80
CH <sub>3</sub> C*N	287.2	BCGH73	CaH <sub>2</sub>	346.8	SMKM77
CH <sub>3</sub> CONH <sub>2</sub>	288.4	SNMK78	CaSe	346.7	FMUK77
EtNH <sub>2</sub>	285.6	BCGH73, GHHL70	CaS	345.9	FMUK77
EtNH <sub>2</sub> BF <sub>3</sub>	286.8	BCGH73	CaCl <sub>2</sub>	346.5	FMUK77
PhNH <sub>2</sub>	284.6	LaFo76	CaF <sub>2</sub>	348.3	Wagn77
C(NH <sub>2</sub> ) <sub>3</sub> Cl	289.4	LeRa77	CaO	347.8	Wagn77, NSLS77
(CH <sub>2</sub> ) <sub>6</sub> N <sub>4</sub>	286.9	GHHL70	CaO	346.1	InYa81
C <sub>5</sub> H <sub>5</sub> N	285.5	BCGH73	CaO	346.7	FMUK77
PhCN	285.4	LaFo76	CaO	347.3	VaVe80
C*H <sub>3</sub> CNB <sub>3</sub>	287.3	BCGH73	CaCO <sub>3</sub>	346.9	Wagn77, CLSW83, WRDM79
CH <sub>3</sub> C*NB <sub>3</sub>	289.1	BCGH73	Ca(NO <sub>3</sub> ) <sub>2</sub>	348.7	CLSW83
Triazole	286.3	GHHL70	CaCrO <sub>4</sub>	346.3	ACHT73
NC*N=C(NH <sub>2</sub> ) <sub>2</sub>	286.4	LeRa77	CaMoO <sub>4</sub>	347.2	NFS82
NCN=C*(NH <sub>2</sub> ) <sub>2</sub>	288.2	LeRa77	CaRh <sub>2</sub> O <sub>4</sub>	345.7	NFS82
H <sub>2</sub> NCH <sub>2</sub> C*OONa	287.9	GHHL70	CaSO <sub>4</sub>	348.0	CLSW83
H <sub>2</sub> NCONH <sub>2</sub>	288.7	GHHL70, LeRa77	CaWO <sub>4</sub>	346.5	Nefe82
H <sub>2</sub> NCSNH <sub>2</sub>	288.0	LeRa77, SrWa77	Ca <sub>3</sub> Si <sub>3</sub> O <sub>9</sub>	347.0	WPHK82
H <sub>2</sub> NCONHCONH <sub>2</sub>	289.3	YYST88			
PhNO <sub>2</sub>	285.3	LaFo76	<b>Ca LMM</b>		
Ph <sub>3</sub> P	284.9	LMF80	Ca	298.2	VaVe80
Ph <sub>3</sub> PO	284.6	LMF80	CaO	292.5	VaVe80
Ph <sub>4</sub> PBr	285.4	LMF80, LaFo76	CaCO <sub>3</sub>	291.9	WRDM79, Wagn77
Ph <sub>4</sub> Sn	284.6	BALS76	CaCl <sub>2</sub>	291.9	Wagn77
p(CH <sub>2</sub> =CHCl)	286.3	PRCV77	CaF <sub>2</sub>	289.1	Wagn77
p(CH <sub>2</sub> =CHOH)	286.3	PRCV77			
p(HOCOCH=CH <sub>2</sub> )	289.0	HHDD81	<b>Cd 3d<sub>5/2</sub></b>		
p(NaOCOCMe=CH <sub>2</sub> )	288.1	HHDD81	Cd	405.1	Φ
p(C*H <sub>3</sub> OCOCH=CH <sub>2</sub> )	286.4	ClTh78	Cd	405.0	GaWi77, HSBS81, WRDM79, Wagn75
p(CH <sub>3</sub> OC*OCH=CH <sub>2</sub> )	288.6	ClTh78	Cd <sub>99</sub> Sn <sub>1</sub>	404.9	HSBS81
p(MeOCOCMe=CH <sub>2</sub> )	289.0	HHDD81			



Hg <sub>0.8</sub> Cd <sub>0.2</sub> Te	404.6	SBB80	K <sub>2</sub> ReCl <sub>6</sub>	198.4	CoHe72
CdTe	404.9	SBB80, GaWi77	K <sub>2</sub> ReCl <sub>6</sub>	199.3	LeBr72
CdSe	405.3	GaWi77	K <sub>2</sub> SnCl <sub>6</sub>	198.4	CoHe72
CdS	405.3	GaWi77	K <sub>2</sub> WCl <sub>6</sub>	199.0	LeBr72
CdI <sub>2</sub>	405.4	GaWi77	K <sub>3</sub> IrCl <sub>6</sub>	198.7	NSBN77
CdBr <sub>2</sub>	406.0	SATD73	K <sub>3</sub> RhCl <sub>6</sub>	198.4	SNMK78
CdCl <sub>2</sub>	406.1	SATD73	K <sub>4</sub> Mo <sub>2</sub> Cl <sub>8</sub>	198.8	HUGH79
CdF <sub>2</sub>	405.9	GaWi77, SATD73, Wagn77	Na <sub>2</sub> PdCl <sub>4</sub>	199.3	SeTs76
CdO	405.2	GaWi77, NGDS75, NFS82, SBB80	Co(NH <sub>3</sub> ) <sub>6</sub> SbCl <sub>6</sub>	198.9	Tric74
CdO <sub>2</sub>	403.6	HGW75	Pt(NH <sub>3</sub> ) <sub>2</sub> Cl <sub>2</sub>	198.8	CMHL77, Nefe78
Cd(OH) <sub>2</sub>	405.0	WRDM79, HGW75	Pt(NH <sub>3</sub> ) <sub>4</sub> Cl <sub>2</sub>	197.8	SNMK78
CdCO <sub>3</sub>	405.1	HGW75	Pt(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>4</sub>	197.8	SNMK78
CdRh <sub>2</sub> O <sub>4</sub>	404.7	NFS82	Rh(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	198.1	Nefe78
<b>Cd MNN</b>					
Cd	383.8	WRDM79, Wagn75,	Cs <sub>3</sub> Sb <sub>2</sub> Cl <sub>9</sub>	198.0	BCH75, Tric74
		GaWi77	CsSbCl <sub>6</sub>	199.2	Tric74
CdTe	382.4	GaWi77	KIrCl <sub>3</sub> NO	198.9	NSBN77
CdSe	381.4	GaWi77	ICl	200.1	Sher76
CdS	381.1	GaWi77	CsClO <sub>4</sub>	208.2	MVS73
CdI <sub>2</sub>	381.0	GaWi77	KClO <sub>3</sub>	206.5	MVS73
CdF <sub>2</sub>	378.8	GaWi77	KClO <sub>4</sub>	208.8	MVS73
CdO	382.2	GaWi77	LiClO <sub>4</sub>	209.0	MVS73
<b>Ce 3d</b>					
Ce	883.8	Φ	NaClO <sub>4</sub>	208.5	MVS73
Ce	883.9	ScOs82	Ni(NH <sub>3</sub> ) <sub>6</sub> (ClO <sub>4</sub> ) <sub>2</sub>	208.2	NZB78
CeAl <sub>2</sub>	883.5	LFBC80	NiClO <sub>4</sub> · 6H <sub>2</sub> O	208.6	NZB78
CePd <sub>3</sub>	884.3	LFBC80	RbClO <sub>4</sub>	208.4	MVS73
CeSe	884.3	LFBC80	Me <sub>4</sub> NCl	196.2	EMGK74
CeCu <sub>2</sub> Si <sub>2</sub>	883.6	LFBC80	Et <sub>4</sub> NCl	196.4	EMGK74
CeO <sub>2</sub>	881.8	WRDM79	Ph <sub>4</sub> NCl	196.1	HHV79
CeO <sub>2</sub>	882.4	NGDS75, SaRa80	NH <sub>4</sub> Cl	197.9	EMGK74
CeH <sub>3</sub>	886.0	ScOs82	Chlorobenzene	200.1	CKAM75
<b>Cl 2p</b>					
KCl	198.5	Φ	Pentachlorobenzene	200.0	CKAM75
CsCl	196.3	MVS73	ClRh(Ph <sub>3</sub> P) <sub>3</sub>	198.0	Nefe78, OII79, MMRC72
KCl	198.2	MVS73, NSLS77, YYS78	(Et <sub>3</sub> P) <sub>2</sub> PtHCl	198.0	Rigg72
NaCl	198.4	MVS73, NSLS77, SGS070	(Ph <sub>3</sub> P) <sub>2</sub> PtHCl, trans	197.1	CBA73
LiCl	198.5	MVS73, CSFG79	(Et <sub>3</sub> P) <sub>2</sub> PtCl <sub>4</sub>	199.2	LeBr72, Nefe78, Rigg72
RbCl	197.9	MVS73	(Et <sub>3</sub> P) <sub>2</sub> PtCl <sub>2</sub>	198.1	Rigg72
CuCl <sub>2</sub>	200.0	VWHS81	(Ph <sub>3</sub> P) <sub>2</sub> NiCl <sub>2</sub>	199.0	BNSA70, STHU76
NiCl <sub>2</sub>	199.4	KIHe83, TRLK73, YYS 78	(Ph <sub>3</sub> P) <sub>2</sub> NiCl <sub>2</sub>	198.3	NZB78
PdCl <sub>2</sub>	198.9	NKBP73	Ph <sub>3</sub> PBCl <sub>3</sub>	199.4	HHV79
RhCl <sub>3</sub>	199.3	OII79	Ph <sub>3</sub> POBCl <sub>3</sub>	198.9	HHV79
RhCl <sub>3</sub> · 12H <sub>2</sub> O	199.2	CMHL77	(Nb <sub>6</sub> Cl <sup>+</sup> ) <sub>12</sub> Cl <sub>6</sub> (Et <sub>4</sub> N) <sub>3</sub>	199.4	BeWa79
SbCl <sub>5</sub>	199.7	BCH 75	(Nb <sub>6</sub> Cl <sub>12</sub> )Cl <sup>+</sup> <sub>6</sub> (Et <sub>4</sub> N) <sub>3</sub>	197.5	BeWa79
ZnCl <sub>2</sub>	198.5	KIHe83	CdCl <sub>2</sub>	199.0	SATD73
K <sub>2</sub> I <sub>2</sub> Cl <sub>6</sub>	198.6	NSBN77, LeBr72, CoHe72	CuCl <sub>2</sub>	199.2	YY78
K <sub>2</sub> MoCl <sub>6</sub>	198.4	CoHe72	HgCl <sub>2</sub>	198.7	SATD73
K <sub>2</sub> OsCl <sub>6</sub>	198.6	CoHe72, LeBr72	InCl	198.4	FHT77
K <sub>2</sub> PdCl <sub>4</sub>	198.8	NKBP73	InCl <sub>3</sub>	199.0	FHT77
K <sub>2</sub> PtCl <sub>4</sub>	198.8	CMHL77, SNMK78	TiCl <sub>4</sub>	198.2	MRV83
K <sub>2</sub> PtCl <sub>6</sub>	198.8	CoHe72, LeBr72, SNMK78	UCl <sub>3</sub>	198.1	TBVL82
			UCl <sub>4</sub>	197.7	TBVL82
			UCl <sub>5</sub>	197.7	TBVL82
			UOCl	198.5	TBVL82
			UOCl <sub>2</sub>	198.3	TBVL82
			ZnCl <sub>2</sub>	199.7	SATD73
			(NH <sub>4</sub> ) <sub>2</sub> PtCl <sub>4</sub>	198.2	KaEl79
			OPCl <sub>3</sub>	201.7	FIWe75

KClO <sub>3</sub>	206.5	NZK77	Br <sub>4</sub> Co(Et <sub>4</sub> N) <sub>2</sub>	780.1	EMGK74
KClO <sub>4</sub>	208.7	NZK77	Cl <sub>4</sub> Co(Et <sub>4</sub> N) <sub>2</sub>	780.6	EMGK74
HCPt(Ph <sub>3</sub> P) <sub>2</sub>	197.9	AL77	Cl <sub>2</sub> Co(thiourea) <sub>2</sub>	780.9	NBMO73
HCPt(Et <sub>3</sub> P) <sub>2</sub>	198.0	AL77			
Cl <sub>2</sub> Pt(Ph <sub>3</sub> P) <sub>2</sub>	198.0	AL77			
Ph <sub>4</sub> PCuCl <sub>2</sub>	198.9	FSJL83	Cr 2p		
Ph <sub>4</sub> PCuCl <sub>3</sub>	199.0	FSJL83	Cr	574.4	Φ
C <sub>6</sub> H <sub>5</sub> Cl	201.0	CKM71	Cr <sub>2</sub> O <sub>3</sub>	576.9	Φ
C <sub>6</sub> H <sub>5</sub> CCl <sub>3</sub>	201.0	CKM71	Cr	574.3	LANM81
C(NH <sub>2</sub> ) <sub>2</sub> Cl	198.0	LeRa77	Cr	574.3	WRDM79
p(CH <sub>2</sub> =CHCl)	200.0	PRCV77, WRDM79	Cr <sub>2</sub> N	576.1	RoRo76
			CrN	575.8	STAB76
			CrB <sub>2</sub>	574.3	MECC73
			Cr <sub>2</sub> S <sub>3</sub>	574.8	CSC72
Co 2p			CrI <sub>3</sub>	576.7	CSC72
Co	778.3	Φ	CrBr <sub>3</sub>	576.2	CSC72
CoO	780.4	Φ	CrCl <sub>3</sub>	577.4	CSC72
Co	778.3	LANM81	Cr <sub>2</sub> O <sub>3</sub>	576.8	BDFP81, CDFM82, CSC72, WRDM79, NGDS75
Co <sub>2</sub> OSn <sub>80</sub>	777.9	ThSh78	CrO <sub>2</sub>	576.3	IIKK76
Co <sub>2</sub> B	778.4	MECC73	CrO <sub>3</sub>	578.3	ACHT73
CoB	778.0	MECC73	CrF <sub>3</sub>	580.3	CSC72
CoS	781.9	Limo81	CrO <sub>3</sub>	579.8	CDFM82
CoF <sub>2</sub>	783.0	CSC72	Cr(OH) <sub>3</sub>	577.3	CDFM82
CoF <sub>2</sub> · 4H <sub>2</sub> O	782.6	NBMO73	CrOOH	577.0	IIKK76
CoF <sub>3</sub>	782.4	CSC72	Cr(CO) <sub>6</sub>	576.3	BCGH72, BCHM72
CoO	780.2	WRDM79	Cr(CO) <sub>6</sub>	577.0	PFD73
CoO	780.4	Kim75, NGDS75, NFS82, CBR76	Cs <sub>2</sub> CrO <sub>4</sub>	579.8	AT76
Co <sub>3</sub> O <sub>4</sub>	780.2	NGDS75, OkHi76	Cs <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	579.5	AT76
Co <sub>3</sub> O <sub>4</sub>	779.5	GPDG79	CuCrO <sub>2</sub>	576.4	ACHT73
Co <sub>2</sub> O <sub>3</sub>	779.9	McCo75	CuCr <sub>2</sub> O <sub>4</sub>	577.1	CDFM82
CoOOH	780.0	McCo75	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	579.9	NSSP80
Co(OH) <sub>2</sub>	781.0	McCo75	LaCrO <sub>3</sub>	575.8	HoTh80
CoAl <sub>2</sub> O <sub>4</sub>	780.8	OkHi76	Li <sub>2</sub> CrO <sub>4</sub>	579.8	ACHT73
CoAl <sub>2</sub> O <sub>4</sub>	781.9	PCLH76	LiCrO <sub>2</sub>	577.0	ACHT73
CoCr <sub>2</sub> O <sub>4</sub>	780.2	OkHi76	Na <sub>2</sub> CrO <sub>4</sub>	579.8	ACHT73
CoFe <sub>2</sub> O <sub>4</sub>	779.7	OkHi76	Na <sub>2</sub> CrO <sub>4</sub>	580.5	LaKe76
CoMn <sub>2</sub> O <sub>4</sub>	780.0	OkHi76	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	579.4	ACHT73
CoMoO <sub>4</sub>	780.9	GPDG79	Na <sub>3</sub> CrO <sub>4</sub>	578.5	LaKe76
CoMoO <sub>4</sub>	782.8	PCLH76	Na <sub>4</sub> CrO <sub>4</sub>	577.9	LaKe76
CoRh <sub>2</sub> O <sub>4</sub>	781.2	NFS82	NaCrO <sub>2</sub>	577.1	LaKe76, ACHT73
CoSO <sub>4</sub>	784.0	Limo81	ZnCr <sub>2</sub> O <sub>4</sub>	577.2	BDFP81
ZnCo <sub>2</sub> O <sub>4</sub>	780.4	OkHi76	BaCrO <sub>4</sub>	579.1	AlTu76
Cs <sub>2</sub> CoI <sub>4</sub>	780.5	NBMO73	CaCrO <sub>4</sub>	578.9	ACHT73
Cs <sub>2</sub> CoBr <sub>4</sub>	780.8	NBMO73	(NH <sub>4</sub> ) <sub>3</sub> CrF <sub>6</sub>	579.5	AlTu76
Cs <sub>2</sub> CoCl <sub>4</sub>	781.0	NBMO73	Cr(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	578.5	AlTu76
K <sub>3</sub> Co(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub>	780.9	CSC72	K <sub>3</sub> Cr(CN) <sub>6</sub>	576.3	Vann76, ZeHa71
K <sub>3</sub> Co(NO <sub>2</sub> ) <sub>6</sub>	781.8	NBMO73	K <sub>3</sub> CrF <sub>6</sub>	583.0	AlTu76
Co(CO) <sub>3</sub> NO	780.7	BCGH72	Cr(acac) <sub>3</sub>	577.7	AlTu76
K <sub>3</sub> Co(CN) <sub>6</sub>	781.2	OkHi76	Cr(acac) <sub>3</sub>	576.1	ZeHa71
K <sub>3</sub> Co(CN) <sub>6</sub>	782.1	Vann76	Cl <sub>3</sub> Cr(urea) <sub>6</sub>	579.9	AlTu76
Co(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	781.4	NBMO73	Cr(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	574.8	BCDH73, CDH 74, GSMJ74
Co(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	781.9	YNAB77	Cr(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	576.3	ClAd71
Co(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	781.1	CSC72	Cr(C <sub>5</sub> H <sub>5</sub> )(C <sub>7</sub> H <sub>7</sub> )	574.4	CDH74, GSMJ74
Co(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	781.8	NBMO73	Cr(C <sub>6</sub> H <sub>6</sub> ) <sub>2</sub>	574.1	CDH74
Co(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	779.1	BCDH73	Cr(C <sub>6</sub> H <sub>6</sub> ) <sub>2</sub>	575.4	PFD73
Co(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	781.3	ClAd71	Cr(CO) <sub>5</sub> PH <sub>3</sub>	575.3	BCGH72

Cr(CO) <sub>5</sub> NH <sub>3</sub>	575.5	BCGH72, BCHM72	CuBr <sub>2</sub>	932.3	VWHS81
Cr(CO) <sub>3</sub> C <sub>6</sub> H <sub>6</sub>	575.7	CDH74	CuCl	932.5	GaWi77, Wagn75
Cr(CO) <sub>3</sub> C <sub>6</sub> H <sub>6</sub>	576.3	PFD73	CuCl <sub>2</sub>	934.4	GaWi77
Cr(CO) <sub>5</sub> (Me <sub>3</sub> P)	575.2	BCGH72, BCHM72	CuCl <sub>2</sub>	935.2	WRDM79
Cl <sub>3</sub> Cr(C <sub>5</sub> H <sub>5</sub> )	576.1	GSMJ74	CuCl <sub>2</sub>	934.8	VWHS81
ICr(C <sub>6</sub> H <sub>6</sub> )	576.4	CDH74	CuCl <sub>2</sub>	935.6	YY78
<b>Cr LMM</b>					
Cr	527.2	WRDM79	CuF <sub>2</sub>	936.1	GaWi77
<b>Cs 3ds/2</b>					
Cs	726.4	Φ	CuF <sub>2</sub>	937.0	WRDM79
Cs	726.0	KDR77	Cu <sub>2</sub> O	936.8	VWHS81
CsI	723.9	MVS73	CuO	932.5	CDFM82, GaWi77, Wagn75, HMUZ78, MSSS81, Scho73b
CsBr	724.0	MVS73	Cu(OH) <sub>2</sub>	933.7	HMUZ78, GaWi77, WRDM79, MSSS81
CsCl	723.7	MVS73	Cu(NO <sub>3</sub> ) <sub>2</sub>	935.1	MSSS81
CsF	724.0	MVS73	CuCN	935.5	NZK77
CsN <sub>3</sub>	723.6	SGRS72	CuC(CN) <sub>3</sub>	933.1	Wagn75
Cs <sub>2</sub> SO <sub>4</sub>	723.9	Wagn77	CuCO <sub>3</sub>	933.2	NZK77
Cs <sub>2</sub> PO <sub>4</sub>	723.9	MVS73	CuSO <sub>4</sub>	935.0	WRDM79
Cs <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	723.8	MVS73	CuSiO <sub>3</sub>	934.9	Limo81
Cs <sub>2</sub> ClO <sub>4</sub>	724.2	MVS73	Cu <sub>2</sub> Mo <sub>3</sub> O <sub>10</sub>	935.5	NZK77
Cs <sub>2</sub> CrO <sub>4</sub>	724.5	ACHT73	Cu <sub>3</sub> Mo <sub>2</sub> O <sub>9</sub>	931.6	HMUZ78
Cs <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	723.9	ACHT73	Cu <sub>2</sub> Cr <sub>2</sub> O <sub>4</sub>	934.1	HMUZ78
CsOH	724.5	WRDM79	CuCrO <sub>2</sub>	934.6	CDFM82
<b>Cs MNN</b>					
Cs <sub>2</sub> SO <sub>4</sub>	568.4	Wagn77	CuFe <sub>2</sub> O <sub>4</sub>	932.3	ACHT73
CsOH	586.7	WRDM79	CuFeO <sub>2</sub>	933.8	LDDB80
<b>Cu 2p</b>					
Cu	932.7	Φ	CuMoO <sub>4</sub>	932.6	LDDB80
CuO	933.6	Φ	CuRh <sub>2</sub> O <sub>4</sub>	934.1	HMUZ78
Cu	932.6	ALMP82	Cu(OAc) <sub>2</sub>	934.4	NFS82
Cu	932.6	LANM81	Cu(OAc) <sub>2</sub>	931.8	BrFr74
Cu	932.6	BiSw80	Cu(acac) <sub>2</sub>	935.0	YY79
Cu	932.6	BiSw80	Cu(8-Hydroxyquinol.)	934.5	BrFr74
Cu	932.7	BiSw80	Cu Salicylaldoxime	935.0	BrFr74
Cu	932.7	PEJ82	Cu <sub>4</sub> Cu(Et <sub>4</sub> N) <sub>2</sub>	934.0	BuBu74
Cu	932.6	Asam76, GaWi77, KPMI73, WRDM79, Wagn75	Cu <sub>2</sub> Cu(H <sub>2</sub> NCONHCONH <sub>2</sub> ) <sub>20</sub>	932.5	EMGK74
Cu <sub>64</sub> Zn <sub>36</sub>	932.6	VanO77		935.8	YY78
Cu <sub>95</sub> S <sub>5</sub>	932.5	Hegd82	<b>Cu LMM</b>		
Cu <sub>3</sub> P	932.2	NSDU75	Cu	918.6	BiSw80
Cu <sub>3</sub> P	932.2	NSDU75	Cu	918.7	BiSw80
Cu <sub>2</sub> Se	931.9	RRD78	Cu	918.6	BiSw80
CuSe	932.0	RRD78	Cu	918.7	PEJ82
CuAgSe	931.9	RRD78	Cu <sub>64</sub> Zn <sub>36</sub>	918.6	VanO77
CuInSe <sub>2</sub>	931.9	KJID81	Cu <sub>2</sub> Se	917.6	RRD78
Cu <sub>2</sub> S	932.5	Wagn75	CuSe	918.4	RRD78
CuS	932.2	RRD78	CuAgSe	917.7	RRD78
CuS	933.2	Limo81	Cu <sub>2</sub> S	917.4	Wagn75
CuS	931.9	BSRR81	CuS	917.9	RRD78
CuS	935.0	NSSP80	CuBr <sub>2</sub>	916.9	VWHS81
CuBr	932.1	BrFr74	CuCl	915.0	Wagn75
			CuCl	915.6	GaWi77
			CuCl <sub>2</sub>	915.3	WRDM79, VWHS81, GaWi77
			CuF <sub>2</sub>	916.0	GaWi77
			CuF <sub>2</sub>	914.8	WRDM79

CuF <sub>2</sub>	914.4	VWHS81	MgF <sub>2</sub>	685.8	Wagn80
Cu <sub>2</sub> O	916.2	CDFM82, HMUZ78	MgF <sub>2</sub>	685.7	NBK74
Cu <sub>2</sub> O	916.2	CDFM82, GaWi77, Wagn75, HMUZ78, MSSS81, Scho73b	SrF <sub>2</sub>	685.0	WRDM79
Cu <sub>2</sub> O	916.6	MSSS81, Wagn75	SrF <sub>2</sub>	684.5	NBK74
Cu <sub>2</sub> O	917.2	GaWi77	AgF	682.7	GaWi77
CuO	918.1	GaWi77, MSSS81, Scho73b	BeF <sub>2</sub>	685.8	NBK74, NKBP73
Cu(OH) <sub>2</sub>	916.2	MSSS81	CdF <sub>2</sub>	684.5	GaWi77, WRDM79
Cu(NO <sub>3</sub> ) <sub>2</sub>	915.3	NZK77	CdF <sub>2</sub>	684.2	NSLS77
CuCN	914.5	Wagn75	CuF <sub>2</sub>	684.5	GaWi77, WRDM79
CuC(CN) <sub>3</sub>	914.5	NZK77	CuF <sub>2</sub>	685.9	VWHS81
CuCO <sub>3</sub>	916.3	WRDM79	HgF <sub>2</sub>	686.0	SATD73
CuSO <sub>4</sub>	915.6	NZK77	MnF <sub>2</sub>	684.8	WRDM79
CuSiO <sub>3</sub>	915.2	WRDM79	NiF <sub>2</sub>	685.0	GaWi77, WRDM79
Cu <sub>2</sub> Mo <sub>3</sub> O <sub>10</sub>	916.5	HMUZ78	NiF <sub>2</sub> · 4H <sub>2</sub> O	684.7	NSLS77
Cu <sub>2</sub> Mo <sub>2</sub> O <sub>9</sub>	916.6	HMUZ78	PbF <sub>2</sub>	683.6	WRDM79
CuCr <sub>2</sub> O <sub>4</sub>	918.0	CDFM82	ZnF <sub>2</sub>	684.6	GaWi77, Wagn77
CuMoO <sub>4</sub>	916.6	HMUZ78	ZnF <sub>2</sub>	685.1	NBK74
<b>Dy 4d</b>					
Dy	152.4	Φ	AlF <sub>3</sub> · 3H <sub>2</sub> O	686.3	NBK74, NKBP73
Dy <sub>2</sub> O <sub>3</sub>	167.7	SaRa80	GaF <sub>3</sub> · 3H <sub>2</sub> O	685.2	NBK74, NKBP73
<b>Dy 3d<sub>5/2</sub></b>					
Dy	1295.5	Φ	GdF <sub>3</sub>	684.8	McTh76
Dy <sub>2</sub> O <sub>3</sub>	1298.9	SaRa80	InF <sub>3</sub>	685.2	WRDM79
<b>Er 4d</b>					
Er	167.3	Φ	InF <sub>3</sub> · 3H <sub>2</sub> O	685.3	NBK74, NKBP73
Er	169.4	WRDM79	LaF <sub>3</sub>	684.5	WRDM79
Er <sub>2</sub> O <sub>3</sub>	168.7	WRDM79	NdF <sub>3</sub>	684.8	WRDM79
<b>Eu 3d<sub>5/2</sub></b>					
Eu	1125.6	Φ	PrF <sub>3</sub>	684.6	WRDM79
<b>Eu 4d</b>					
Eu	128.2	NNBF68	SmF <sub>3</sub>	684.6	WRDM79
Eu <sub>2</sub> O <sub>3</sub>	135.9	NNBF68	YF <sub>3</sub>	685.3	WRDM79
<b>F 1s</b>					
LiF	684.9	Φ	UF <sub>3</sub>	685.3	TBVL82
CsF	685.9	WRDM79	UF <sub>4</sub>	684.8	TBVL82, PMDS77
KF	683.9	NBK74, MVS73	UF <sub>5</sub>	684.8	TBVL82
KF	684.4	PMDS77	ThF <sub>4</sub>	684.9	WRDM79
LiF	685.1	WRDM79	HfF <sub>4</sub>	685.4	WRDM79
LiF	685.0	MVS73, NBK74	ZrF <sub>4</sub>	685.1	NKBP73
NaF	684.5	WRDM79	NaBeF <sub>3</sub>	685.7	NKBP73
NaF	684.5	NBK74, NSLS77	Na <sub>2</sub> BeF <sub>4</sub>	685.2	NKBP73
NaF	683.7	MVS73	NaBF <sub>4</sub>	687.0	WRDM79
RbF	683.6	MVS73	NaF <sub>4</sub> BF <sub>4</sub>	694.2	RNS73
RbF	682.9	NBK74	Na <sub>3</sub> AlF <sub>6</sub>	685.5	WRDM79
BaF <sub>2</sub>	683.7	WRDM79	Na <sub>2</sub> SiF <sub>6</sub>	686.0	Wagn77
BaF <sub>2</sub>	684.3	NBK74	Na <sub>2</sub> SiF <sub>6</sub>	686.4	NSLS77
CaF <sub>2</sub>	684.8	WRDM79	K <sub>2</sub> SiF <sub>6</sub>	686.6	NBK74
CaF <sub>2</sub>	684.8	NBK74, NSLS77	K <sub>2</sub> TiF <sub>6</sub>	685.0	WRDM79
			K <sub>2</sub> TiF <sub>6</sub>	685.0	WRDM79
			K <sub>2</sub> TiF <sub>6</sub>	684.9	NBK74
			K <sub>2</sub> TiF <sub>6</sub>	684.9	NBK74
			K <sub>2</sub> TiF <sub>6</sub>	685.3	Wagn77
			K <sub>3</sub> FeF <sub>6</sub>	684.0	WRDM79
			K <sub>2</sub> NiF <sub>6</sub>	687.6	TRLK73
			K <sub>2</sub> GeF <sub>6</sub>	685.2	NBK74
			Na <sub>2</sub> GeF <sub>6</sub>	685.9	WRDM79
			K <sub>2</sub> ZrF <sub>6</sub>	684.6	NBK74, NKBP73
			Na <sub>2</sub> ZrF <sub>6</sub>	685.0	WRDM79
			KZrF <sub>5</sub> · H <sub>2</sub> O	684.8	NKBP73
			K <sub>3</sub> ZrF <sub>7</sub>	684.3	NKBP73
			NaSnF <sub>3</sub>	685.3	WRDM79
			K <sub>2</sub> SnF <sub>6</sub> · H <sub>2</sub> O	685.1	NBK74
			CsSbF <sub>4</sub>	683.6	BCH75

K <sub>2</sub> SbF <sub>6</sub>	683.9	Tric74	NaBF <sub>4</sub>	652.8	WRDM79
KSbF <sub>6</sub>	686.6	Wagn77	Na <sub>3</sub> AlF <sub>6</sub>	654.1	WRDM79
KSb <sub>2</sub> F <sub>7</sub>	684.3	Tric74	Na <sub>2</sub> SiF <sub>6</sub>	653.0	Wagn77
Na <sub>2</sub> SbF <sub>5</sub>	683.4	Tric74	K <sub>2</sub> TiF <sub>6</sub>	655.7	WRDM79
NaSbF <sub>6</sub>	685.1	BCH75	Na <sub>2</sub> TiF <sub>6</sub>	655.1	Wagn77
K <sub>3</sub> RhF <sub>6</sub>	685.7	Nefe78	K <sub>3</sub> FeF <sub>6</sub>	656.0	WRDM79
K <sub>2</sub> NbF <sub>7</sub>	685.4	WRDM79	Na <sub>2</sub> GeF <sub>6</sub>	654.0	WRDM79
K <sub>2</sub> NbF <sub>7</sub>	685.2	NBK74	Na <sub>2</sub> ZrF <sub>6</sub>	655.1	WRDM79
K <sub>2</sub> TaF <sub>7</sub>	685.2	WRDM79	NaSnF <sub>3</sub>	655.3	WRDM79
K <sub>2</sub> TaF <sub>7</sub>	685.1	NBK74	KSbF <sub>6</sub>	656.6	Wagn77
NaTaF <sub>6</sub>	685.2	NKBP73	K <sub>2</sub> NbF <sub>7</sub>	655.2	WRDM79
Na <sub>2</sub> TaF <sub>7</sub>	685.6	NKBP73	K <sub>2</sub> TaF <sub>7</sub>	655.0	WRDM79
Na <sub>3</sub> TaF <sub>8</sub>	685.5	NKBP73	p-(CF <sub>2</sub> =CF <sub>2</sub> )	652.4	Wagn77
K <sub>2</sub> UF <sub>6</sub>	684.7	PMDS77	NiOOCCF <sub>3</sub>	652.9	WRDM79
EuOF	685.3	RGBH80			
LaOF	685.2	RGBH80			
NdOF	685.1	RGBH80	<b>Fe 2p</b>		
PrOF	685.0	RGBH80	Fe	707.0	Φ
YOF	685.5	RGBH80	Fe <sub>2</sub> O <sub>3</sub>	710.9	Φ
Cs <sub>2</sub> MoO <sub>2</sub> F <sub>4</sub>	684.7	NKBP73	Fe	706.7	LANM81
Cs <sub>2</sub> WO <sub>2</sub> F <sub>4</sub>	684.7	NKBP73	Fe	706.8	Asam76
UO <sub>2</sub> F <sub>2</sub>	685.6	TBVL82	Fe <sub>3</sub> Al	707.0	WRDM79, McZe77
p-(CF <sub>2</sub> =CF <sub>2</sub> )	689.0	Wagn77	Fe <sub>3</sub> Si	707.6	ShTr75
NiOOCCF <sub>3</sub>	688.4	WRDM79	Fe <sub>2</sub> B	707.5	ShTr75
CH <sub>3</sub> CNBF <sub>3</sub>	687.0	BCGH73	FeB	706.9	MECC73
NH <sub>3</sub> BF <sub>3</sub>	686.6	BCGH73	Fe <sub>3</sub> C	707.1	MECC73
C <sub>5</sub> H <sub>5</sub> NBF <sub>3</sub>	685.6	BCGH73	FeS	708.1	ShTr75
EtNH <sub>2</sub> BF <sub>3</sub>	686.6	BCGH73	FeS	710.3	CSC72
Et <sub>4</sub> NSbF <sub>6</sub>	684.7	BCH75	FeS <sub>2</sub> (markasite, pyr)	712.2	Bind73, Limo81
Ph <sub>3</sub> PBF <sub>3</sub>	685.7	HVV79	KFeS <sub>2</sub>	706.7	Bind73
Ph <sub>3</sub> POBF <sub>3</sub>	685.8	HVV79	FeBr <sub>2</sub>	708.7	Bind73
			FeBr <sub>3</sub>	710.3	CSC72
			FeCl <sub>2</sub>	710.1	CSC72
			FeCl <sub>3</sub>	710.6	CSC72
			FeF <sub>2</sub>	711.3	CSC72
			FeF <sub>3</sub>	711.3	CSC72
			FeO	714.2	CSC72
			Fe <sub>3</sub> O <sub>4</sub>	709.4	McZe77
			Fe <sub>3</sub> O <sub>4</sub>	708.2	McZe77
			Fe <sub>2</sub> O <sub>3</sub>	710.4	OkHi76
			Fe <sub>2</sub> O <sub>3</sub> , alpha	710.8	WRDM79, NGDS75
			Fe <sub>2</sub> O <sub>3</sub> , gamma	710.9	McZe77
			FeOOH, alpha	710.9	McZe77
			FeOOH, gamma	711.8	McZe77
			CoFe <sub>2</sub> O <sub>4</sub>	711.3	KoNa80
			Fe(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	710.5	McZe77
			FeSO <sub>4</sub>	713.6	Kilk73
			K <sub>3</sub> FeF <sub>6</sub>	712.1	Limo81
			NiFe <sub>2</sub> O <sub>4</sub>	714.4	CSC72
			K <sub>3</sub> Fe(CN) <sub>6</sub>	710.5	McZe77
			K <sub>4</sub> Fe(CN) <sub>6</sub>	709.6	Vann76
			K <sub>4</sub> Fe(CN) <sub>6</sub>	707.1	Vann76
			Na <sub>2</sub> Fe(CN) <sub>3</sub> (NO)	708.5	YNNA77
			Na <sub>3</sub> Fe(CN) <sub>3</sub> (N <sub>2</sub> O)	709.7	YNNA77
			Na <sub>4</sub> Fe(CN) <sub>3</sub> (NO <sub>2</sub> )	707.4	YNNA77
			Na <sub>3</sub> Fe(CN) <sub>3</sub> NH <sub>3</sub>	706.8	YNNA77
				707.6	YNNA77

**F KLL**

CsF	653.8	WRDM79			
LiF	654.7	WRDM79			
NaF	655.0	Wagn77			
BaF <sub>2</sub>	656.2	WRDM79			
CaF <sub>2</sub>	655.4	WRDM79			
MgF <sub>2</sub>	654.4	Wagn77			
SrF <sub>2</sub>	656.3	WRDM79			
AgF	659.3	GaWi77			
CdF <sub>2</sub>	656.0	GaWi77, WRDM79			
CuF <sub>2</sub>	657.0	GaWi77			
CuF <sub>2</sub>	656.2	WRDM79			
CuF <sub>2</sub>	656.2	WRDM79			
NiF <sub>2</sub>	655.5	GaWi77, WRDM79			
PbF <sub>2</sub>	658.5	WRDM79			
ZnF <sub>2</sub>	655.6	GaWi77, WRDM79			
InF <sub>3</sub>	656.4	WRDM79			
LaF <sub>3</sub>	658.0	WRDM79			
NdF <sub>3</sub>	657.0	WRDM79			
PrF <sub>3</sub>	657.2	WRDM79			
SmF <sub>3</sub>	657.0	WRDM79			
YF <sub>3</sub>	655.8	WRDM79			
ThF <sub>4</sub>	657.0	WRDM79			
HfF <sub>4</sub>	655.3	WRDM79			

Na <sub>3</sub> Fe(CN) <sub>5</sub> N <sub>2</sub> H <sub>4</sub>	707.7	YNNA77	Gd <sub>2</sub> O <sub>3</sub>	143.8	SaRa80
Fe(CO) <sub>5</sub>	709.6	BCGH72			
Fe(CO) <sub>2</sub> (NO) <sub>2</sub>	709.5	BCGH72	<b>Gd 3d</b>		
KFe <sub>4</sub> (NO) <sub>3</sub> S <sub>3</sub> · 2H <sub>2</sub> O	708.9	Nefe78	Gd	1187.0	Φ
Fe(SMe)(CO) <sub>3</sub>	708.6	BBFR77	Gd <sub>2</sub> O <sub>3</sub>	1189.0	SaRa80
Fe(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	707.7	FWUM79, BCDH73, CDH74, Nefe78			
I <sub>3</sub> Fe(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	709.9	CDH74	<b>Ge 2p<sub>3/2</sub></b>		
Fe(C <sub>5</sub> H <sub>4</sub> COOH) <sub>2</sub>	708.4	FWUM79	Ge	1217.2	McWe76
Fe(phthalocyanine)	709.1	MSV79	Ge	1217.4	TLR78, MoVa73, Wagn75
<b>Fe LMM</b>			GeS <sub>2</sub>	1219.8	MoVa73
Fe	702.4	WRDM79	GeS <sub>2</sub>	1219.8	MoVa73
			GeN <sub>4</sub>	1218.8	TLR78
<b>Ga 2p<sub>3/2</sub></b>			GeI <sub>2</sub>	1218.2	MoVa73
Ga	1116.7	Φ	GeF <sub>2</sub>	1220.7	MoVa73
Ga	1116.5	Scho73a	GeO <sub>2</sub>	1220.4	MoVa73, Wagn75
GaP	1116.8	NSDU75	Na <sub>2</sub> GeO <sub>3</sub>	1218.9	MoVa73
Ga <sub>2</sub> O <sub>3</sub>	1116.9	BDFP81	Na <sub>2</sub> GeF <sub>6</sub>	1221.3	Wagn75
Ga <sub>2</sub> O <sub>3</sub>	1117.8	Scho73a	K <sub>2</sub> GeF <sub>6</sub>	1220.7	MoVa73
			Ph <sub>4</sub> Ge	1218.9	MoVa73
<b>Ga LMM</b>			<b>Ge LMM</b>		
Ga	1068.2	WRDM79, MINN78, Scho73a	Ge	1146.2	McWe76
GaAs	1066.3	MINN78	Ge	1145.4	SFS77
GaAs	1067.1	MINN78	Ge	1145.1	Wagn75, WRDM79
GaP	1065.6	MINN78, MIN81	GeTe	1144.8	SFS77
GaP	1066.8	MIN81	GeSe	1143.8	SFS77
GaN	1064.5	HeMa80	GeS	1143.7	SFS77
Ga <sub>2</sub> Se <sub>3</sub>	1065.2	ITI82	GeO <sub>2</sub>	1137.7	Wagn75
Ga <sub>2</sub> Se <sub>3</sub>	1065.6	ITI82	Na <sub>2</sub> GeF <sub>6</sub>	1135.7	Wagn75
Ga <sub>2</sub> O <sub>3</sub>	1061.6	MINN78			
Ga <sub>2</sub> O <sub>3</sub>	1062.4	ITI82	<b>Ge 3d</b>		
Ga <sub>2</sub> O <sub>3</sub>	1062.9	Scho72a	Ge	29.4	Φ
			Ge	29.3	McWe76
<b>Ga 3d</b>			Ge	29.0	SFS77
Ga	18.6	MINN78, LBHK73, Scho73a, WRDM79	Ge	29.1	HKMP74, UeOd82, WRDM79
GaSb	20.2	LBHK73	GeAs <sub>2</sub>	29.7	HKMP74
GaAs	18.8	LPMK74	GeTe <sub>3</sub> As <sub>2</sub>	29.9	HKMP74
GaAs	19.2	IMNN79, MINN78, Tayl82,	GeS <sub>2</sub> TeAs <sub>2</sub>	30.2	HKMP74
GaP	18.8	MIN81	GeS <sub>3</sub> As	30.4	HKMP74
GaP	19.3	NIMN78, IMNN79	GeTe <sub>2</sub>	30.1	HKMP74
GaP	19.9	LBHK73, MIN81	GeTe	30.0	SFS77
GaP	18.7	LPMK74	GeTe	29.7	HKMP74
GaN	19.5	HeMa80	GeSe <sub>2</sub>	31.0	UeOd82
AlGaAs	19.0	Tayl82	GeSe	30.9	SFS77
Ga <sub>2</sub> Se <sub>3</sub>	19.7	ITI82	GeS <sub>2</sub>	30.4	HKMP74
Ga <sub>2</sub> Se <sub>3</sub>	19.9	ITI82	GeS	30.5	SFS77
Ga <sub>2</sub> O <sub>3</sub>	19.6	GGVL79	GeO <sub>2</sub>	29.5	HKMP74
Ga <sub>2</sub> O <sub>3</sub>	20.2	LBHK73, Scho73a	Ph <sub>4</sub> Ge	32.5	HKMP74
Ga <sub>2</sub> O <sub>3</sub>	20.5	ITI82	Ph <sub>3</sub> GeI	31.2	HWVV74
Ga <sub>2</sub> O <sub>3</sub>	21.0	MINN78	Ph <sub>3</sub> GeBr	31.8	HWVV74
			Ph <sub>3</sub> GeCl	31.8	HWVV74
<b>Gd 4d</b>			<b>Hf 4f</b>		
Gd	140.4	Φ	Hf	14.3	Φ

Hf	14.4	WRDM79	I <sub>2</sub> Ni(Ph <sub>3</sub> P) <sub>2</sub>	619.3	NZB78
HfO <sub>2</sub>	16.7	SaRa80	I <sub>2</sub> Pt(Et <sub>3</sub> P) <sub>2</sub>	619.2	Rigg72
<b>Hf 4d</b>			I <sub>4</sub> In(Pr <sub>4</sub> N)	619.6	FHT77
HfO <sub>2</sub>	213.2	SaRa80, NGDS75	I <sub>2</sub> Pt(Me <sub>3</sub> P) <sub>2</sub> cis	621.1	CAB71
<b>Hg 4f</b>			I <sub>2</sub> Pt(Me <sub>3</sub> P) <sub>2</sub> tran	621.9	CAB71
HgS (cinnabar)	101.0	Φ	I <sub>4</sub> (Mo <sub>6</sub> I <sup>8</sup> )	620.6	BeWa79
Hg	99.8	BrMc72, SATD73, SMBM76, WRDM79	I <sup>4</sup> <sub>4</sub> (Mo <sub>6</sub> I <sub>8</sub> )	619.3	BeWa79
Hg <sub>0.8</sub> Cd <sub>0.2</sub> Te	100.2	SBB80	<b>I MNN</b>		
HgS	100.8	NSSP80	LiI	517.0	WRDM79
HgI <sub>2</sub>	100.7	SATD73	AgI	506.8	GaWi77
HgBr <sub>2</sub>	101.0	SATD73	CdI	507.0	GaWi77
HgCl <sub>2</sub>	101.4	SATD73	CuI	507.1	GaWi77
HgF <sub>2</sub>	101.2	SATD73	Nil <sub>2</sub>	507.3	GaWi77
HgO	100.8	NSSP80	ZnI <sub>2</sub>	506.0	GaWi77
Et <sub>2</sub> NC <sub>6</sub> H <sub>4</sub> HgOAc	101.3	NSSP80	<b>In 3d<sub>5/2</sub></b>		
Cl <sub>2</sub> Hg(H <sub>2</sub> NCONHCONH <sub>2</sub> ) <sub>2</sub>	101.3	YY878	In	443.9	Φ
Hg(thiobenzoylme) <sub>2</sub>	101.3	TBHH77	In	443.8	Bert81, Hegd82, WRDM79, PVVA79, LAK77
(Ph <sub>4</sub> P) <sub>2</sub> Hg(SCN) <sub>4</sub>	101.4	FoLa82	In <sub>95</sub> Sn <sub>5</sub>	443.6	Hegd82
<b>Ho 4d</b>			InSb	444.1	IMNN79
Ho	159.6	Φ	InP	444.6	Bert81, CFRS80
<b>I 3d<sub>5/2</sub></b>			In <sub>2</sub> Te <sub>3</sub>	444.5	WRDM79
KI	619.3	Φ	In <sub>2</sub> Se <sub>3</sub>	444.8	WRDM79
I <sub>2</sub>	619.9	Sher76	In <sub>2</sub> S <sub>3</sub>	444.8	Wagn77, MSC 73
CsI	618.2	MVS73	InI <sub>3</sub>	446.0	Wagn77, MSC 73
RbI	618.2	MVS73	InI	443.9	FHT77
KI	618.8	MVS73	InBr <sub>3</sub>	446.0	Wagn77
NaI	618.6	MVS73, Sher76	InBr	446.6	MSC73
LiI	619.7	WRDM79	InCl <sub>3</sub>	445.1	FHT77
LiI	618.9	MVS73	InCl <sub>3</sub>	446.0	Wagn77
AgI	619.4	GaWi77	InCl	446.9	MSC73
CdI	619.2	GaWi77	InF <sub>3</sub>	446.4	Wagn75, MSC73
CdI	619.4	SATD73	In <sub>2</sub> O <sub>3</sub>	444.3	Wagn77, NGDS75, Bert81
CuI	619.0	GaWi77	In <sub>2</sub> O <sub>3</sub>	444.6	CFRS80
HgI <sub>2</sub>	619.4	SATD73	In <sub>2</sub> O <sub>3</sub>	444.9	LAK77, MSC73
InI	619.0	FHT77	In(OH) <sub>3</sub>	445.0	WRDM79
InI <sub>3</sub>	619.1	FHT77	(NH <sub>4</sub> ) <sub>3</sub> InF <sub>6</sub>	445.6	Wagn77
Nil <sub>2</sub>	619.0	GaWi77	CuInSe <sub>2</sub>	444.7	KJID81
Nil <sub>2</sub> · 6H <sub>2</sub> O	619.7	NZB78	In(acac) <sub>3</sub>	445.4	MSC73
ZnI <sub>2</sub>	619.8	GaWi77	Br <sub>2</sub> InEt <sub>4</sub> N	445.7	FHT77
ZnI <sub>2</sub>	619.7	SATD73	Cl <sub>2</sub> InEt <sub>4</sub> N	445.2	FHT77
NaIO <sub>3</sub>	623.5	Sher76	Br <sub>4</sub> InPt <sub>4</sub> N	445.9	FHT77
NaIO <sub>4</sub>	624.0	Sher76	I <sub>4</sub> InPr <sub>4</sub> N	445.4	FHT77
HIO <sub>3</sub>	623.1	Sher76	Cl <sub>4</sub> InPr <sub>4</sub> N	445.8	FHT77
H <sub>3</sub> IO <sub>6</sub>	623.0	Sher76	<b>In MNN</b>		
I <sub>2</sub> O <sub>5</sub>	623.3	Sher76	In	410.4	WRDM79
ICl	621.5	Sher76	In <sub>95</sub> Sn <sub>5</sub>	410.5	PVVA79, KISC80, LAK77
ICl <sub>3</sub>	622.5	Sher76	InSb	401.6	IMNN79
Cs <sub>3</sub> Sb <sub>2</sub> I <sub>9</sub>	618.5	BCH75	InP	408.0	Bert81
Rb <sub>3</sub> Sb <sub>2</sub> I <sub>9</sub>	620.8	Tric74	InP	411.0	KISC80
Na(NiO <sub>6</sub> ) · H <sub>2</sub> O	624.4	NZB78	In <sub>2</sub> Te <sub>3</sub>	408.9	WRDM79

In <sub>2</sub> Se <sub>3</sub>	408.3	WRDM79	K <sub>2</sub> PtCl <sub>6</sub>	292.8	CoHe72, LeBr72
In <sub>2</sub> S <sub>3</sub>	407.3	Wagn77	K <sub>2</sub> ReCl <sub>6</sub>	292.8	CoHe72
InI <sub>3</sub>	405.8	Wagn77	K <sub>2</sub> ReCl <sub>6</sub>	293.7	LeBr72
InBr <sub>3</sub>	404.8	Wagn77	K <sub>2</sub> SnCl <sub>6</sub>	292.8	CoHe72
InCl <sub>3</sub>	404.6	Wagn77	K <sub>2</sub> WCl <sub>6</sub>	293.3	LeBr72
InF <sub>3</sub>	403.7	Wagn75	K <sub>3</sub> IrCl <sub>6</sub>	293.0	NSBN77
In <sub>2</sub> O <sub>3</sub>	406.4	Wagn77	K <sub>4</sub> Mo <sub>2</sub> Cl <sub>8</sub>	293.2	HUGH79
In(OH) <sub>3</sub>	405.0	WRDM79	KSbFF <sub>6</sub>	293.7	Wagn77
(NH <sub>4</sub> ) <sub>3</sub> InF <sub>6</sub>	404.1	Wagn77	KZrFF <sub>5</sub> · H <sub>2</sub> O	292.7	NKBP73

**Ir 4f**

Ir	60.9	Φ	K <sub>2</sub> UF <sub>6</sub>	293.1	PMDS77
Ir	60.8	WRDM79, BHHK70, EPC75	K <sub>2</sub> ZrF <sub>6</sub>	292.6	NKBP73
IrCl <sub>3</sub>	62.7	Folk73	K <sub>3</sub> ZrF <sub>7</sub>	292.8	NKBP73
K <sub>2</sub> IrBr <sub>6</sub>	62.6	Nefe78K <sub>3</sub> IrBr <sub>6</sub> 61.8Nefe78	K <sub>3</sub> Co(CN) <sub>6</sub>	293.7	Vann76
K <sub>2</sub> IrCl <sub>6</sub>	63.0	CoHe72, LeBr72	K <sub>3</sub> Cr(CN) <sub>6</sub>	292.2	ZeHa71
K <sub>2</sub> IrCl <sub>6</sub>	63.6	KSPB76, NSBN77	K <sub>3</sub> Fe(CN) <sub>6</sub>	291.9	Vann76
K <sub>3</sub> IrCl <sub>6</sub>	62.5	NSBN77	K <sub>3</sub> Mn(CN) <sub>6</sub>	291.9	Vann76
(NH <sub>4</sub> ) <sub>2</sub> IrCl <sub>6</sub>	63.7	EPC75	K <sub>4</sub> Fe(CN) <sub>6</sub>	291.9	Vann76
(NH <sub>4</sub> ) <sub>3</sub> IrCl <sub>6</sub>	63.0	EPC75	K <sub>4</sub> V(CN) <sub>6</sub>	293.7	Vann76
Ir(CO) <sub>3</sub> Cl	63.4	KSPB76	KIrCl <sub>3</sub> NO	293.1	NSBN77
KIrCl <sub>3</sub> NO	65.0	NSBN77	K <sub>2</sub> Pt(CN) <sub>4</sub> · 3H <sub>2</sub> O	293.3	CaLe73
KIr <sub>2</sub> (CO) <sub>4</sub> Cl <sub>4</sub>	62.7	KSPB76	K <sub>2</sub> Pt(CN) <sub>4</sub> Cl <sub>2</sub> · 3H <sub>2</sub> O	292.9	CaLe73
K <sub>2</sub> Ir <sub>2</sub> (CO) <sub>4</sub> Cl <sub>5</sub>	63.0	KSPB76	K <sub>3</sub> Co(SCH <sub>2</sub> CHNH <sub>2</sub> COO) <sub>3</sub>	292.8	SSEW79
IrCl <sub>4</sub> (EteP) <sub>2</sub>	63.6	LeBr72	<b>K LMM</b>		
IrClN <sub>2</sub> (Ph <sub>3</sub> P) <sub>2</sub>	60.7	Folk73	KBr	250.7	WRDM79
IrI <sub>3</sub> (H <sub>2</sub> NCH <sub>2</sub> CH <sub>2</sub> NH <sub>2</sub> ) <sub>3</sub>	63.1	NeBa72	KF	250.1	Wagn77
IrCl <sub>3</sub> (H <sub>2</sub> NCH <sub>2</sub> CH <sub>2</sub> NH <sub>2</sub> ) <sub>3</sub>	63.2	NeBa72	KSbF <sub>6</sub>	249.3	Wagn77
IrCl <sub>6</sub> (H <sub>2</sub> NCH <sub>2</sub> CH <sub>2</sub> NH <sub>2</sub> ) <sub>3</sub>	63.2	Nefe78	<b>Kr 3d</b>		

**K 2p**

K	294.4	Φ	Kr in graphite	87.0	Φ
KCl	292.9	Φ	<b>La 3d</b>		
K	294.6	SMKM77, PeKa77	La	835.8	Φ
KI	292.8	MVS73	La	835.9	ScSc82
KBr	293.0	MVS73, WRDM79	LaH <sub>2</sub>	838.8	ScSc82
KCl	292.8	MVS73, NSLS77	La <sub>2</sub> O <sub>3</sub>	835.1	WRDM79
KF	292.5	Wagn75	La <sub>2</sub> O <sub>3</sub>	833.7	SaRa80
KF	292.8	PMDS77	<b>La 4d</b>		
KF	293.1	MVS73	La	103.9	NIS72, KEML74
KCN	294.7	Vann76	La <sub>2</sub> O <sub>3</sub>	101.3	SaRa80, NGDS75, HoTh80
KN <sub>3</sub>	292.5	SGRS72	LaCrO <sub>3</sub>	101.7	HoTh80
KNO <sub>3</sub>	292.9	NSLS77	<b>Li 1s</b>		
KClO <sub>3</sub>	293.2	MVS73	LiF	55.6	Φ
KClO <sub>4</sub>	293.4	MVS73	Li	54.7	KLMP73, CSFG79
K <sub>2</sub> PO <sub>4</sub>	293.5	MVS73	LiN <sub>3</sub>	55.2	SGRS72
K <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	292.2	MVS73	LiBr	56.8	MVS73
K <sub>2</sub> CrO <sub>4</sub>	292.6	ACHT73	LiCl	56.0	CSFG79, MVS73
K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	292.1	ACHT73	LiF	55.7	MVS73, WRDM79
K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	292.8	NSSP80	Li <sub>2</sub> O	55.6	CSFG79
K <sub>2</sub> MoO <sub>4</sub>	292.6	NFS82	LiOH	54.9	CSFG79
KRhO <sub>2</sub>	292.5	NFS82	Li <sub>2</sub> CO <sub>3</sub>	55.2	CSFG79
KAl <sub>2</sub> (AlSi <sub>3</sub> O <sub>10</sub> ) <sub>2</sub> (OH) <sub>2</sub>	293.0	WPHK82	Li <sub>3</sub> PO <sub>4</sub>	55.4	MVS73
K <sub>2</sub> IrCl <sub>6</sub>	292.8	NSBN77, LeBr72, CoHe72			
K <sub>2</sub> MoCl <sub>6</sub>	292.7	CoHe72			
K <sub>2</sub> OsCl <sub>6</sub>	293.0	CoHe72, LeBr72			

Li <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	55.6	MVS73	MnF <sub>3</sub>	642.6	CSC72
LiClO <sub>4</sub>	57.2	MVS73	MnO	640.7	OHI75
Li <sub>2</sub> CrO <sub>4</sub>	57.1	ACHT73	MnO	640.5	OkHi76
LiCrO <sub>2</sub>	55.6	ACHT73	MnO	641.4	Aoki76, CSC72
LiNbO <sub>3</sub>	54.8	StHo79	Mn <sub>2</sub> O <sub>3</sub> , alpha	641.2	OHI75
<b>Lu 4f</b>					
Lu	7.3	Φ	Mn <sub>2</sub> O <sub>3</sub> , gamma	641.6	CSC72
<b>Lu 4d</b>					
Lu	196.2	KEML74, LPWF75	Mn <sub>2</sub> O <sub>3</sub> , alpha	641.7	OkHi76
Lu <sub>2</sub> O <sub>3</sub>	196.0	SaRa80, NGDS75	Mn <sub>2</sub> O <sub>3</sub> , gamma	641.5	OkHi76
<b>Mg 2p</b>					
Mg	49.8	Φ	Mn <sub>3</sub> O <sub>4</sub>	641.4	OHI75
Mg	49.6	HAS75, LMKJ75, HFV 77, Fugg77, WRDM79	MnO <sub>2</sub>	642.4	WRDM79
Mg <sub>2</sub> Cu	49.8	FWFA75	MnO <sub>2</sub> , beta	641.1	OHI75
Mg <sub>3</sub> Bi <sub>2</sub>	50.6	FWFA75	MnO <sub>2</sub>	642.3	Aoki76, CSC72, NGDS75
MgF <sub>2</sub>	51.0	Wagn80	MnOOH	641.7	OHI75
MgO	50.8	InYa81	CoMn <sub>2</sub> O <sub>4</sub>	641.5	OkHi76
Mg(OH) <sub>2</sub>	49.5	HNUW78a	CuMn <sub>2</sub> O <sub>4</sub>	641.0	OkHi76
MgAl <sub>2</sub> O <sub>4</sub>	50.4	HNUW78b	MnCr <sub>2</sub> O <sub>4</sub>	640.6	OkHi76
Talc, Mg <sub>3</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	50.5	WPHK82	MnSO <sub>4</sub>	644.9	Limo81
<b>Mg 1s</b>					
Mg	1303.1	HAS75, LMKJ75, Fugg77	KMnO <sub>4</sub>	647.0	UmRe78
Mg <sub>2</sub> Cu	1303.0	FWFA75	Mn <sub>2</sub> (CO) <sub>10</sub>	641.6	VVVB77
Mg <sub>3</sub> Bi <sub>2</sub>	1304.0	FWFA75	BrMn(CO) <sub>3</sub>	641.9	VVVB77
MgF <sub>2</sub>	1305.0	Wagn80	(BrMn(CO) <sub>4</sub> ) <sub>2</sub>	641.7	VVVB77
Mg(OH) <sub>2</sub>	1302.7	HNUW78a	BrMn(CO) <sub>4</sub> (Ph <sub>3</sub> P)	641.5	VVVB77
MgAl <sub>2</sub> O <sub>4</sub>	1304.0	HNUW78b	BrMn(CO) <sub>3</sub> (P(OMe) <sub>3</sub> ) <sub>2</sub>	641.0	VVVB77
<b>Mn LMM</b>					
Mn				617.6	Vayr81
<b>Mg KLL</b>					
Mg	1185.5	LMKJ75, SRHH78, WRDM79, Fugg77, HFV 77	Mo	228.0	Φ
Mg <sub>2</sub> Cu	1185.7	FWFA75	Mo	227.9	NyMa80
Mg <sub>3</sub> Bi <sub>2</sub>	1184.6	FWFA75	Mo	228.0	CiDe75, WRDM79, CGR 78, GrMa75, KBAW74, WaTa80
MgF <sub>2</sub>	1178.2	Wagn80	MoB <sub>2</sub>	227.9	MECC73
Talc, Mg <sub>3</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	1180.3	WPHK82	Mo <sub>2</sub> B <sub>5</sub>	227.3	BrWh78
<b>Mn 2p</b>					
Mn	639.0	Φ	Mo <sub>2</sub> C	227.8	BrWh78
MnO <sub>2</sub>	642.1	Φ	MoSi <sub>2</sub>	227.7	WPHK82
Mn	638.8	LANM81	MoSe <sub>2</sub>	228.3	GrMa75
Mn	639.0	WRDM79	MoS <sub>2</sub>	229.0	PCLH76, GrMa75
MnN	641.3	CSC72	MoS <sub>2</sub>	229.6	SSOT81, StEd75
MnS	640.3	CSC72	MoCl <sub>3</sub>	230.0	GrMa75
MnS, beta	640.8	Aoki76	MoCl <sub>4</sub>	230.6	GrMa75, SwHe71
MnS, alpha	641.9	Aoki76	MoCl <sub>5</sub>	231.0	GrMa75, SwHe71
MnS	642.1	Limo81	MoO <sub>2</sub>	229.3	SaRa80, CGR78, CiDe75, KBAW74
MnI <sub>2</sub>	641.9	Aoki76, CSC72	MoO <sub>3</sub>	232.6	GPDG79, KBAW74, SaRa80, CiDe75, CGR78, GrMa75
MnBr <sub>2</sub>	642.0	Aoki76, CSC72	MoO <sub>3</sub>	232.6	WRDM79
MnCl <sub>2</sub>	642.0	Aoki76, CSC72	(NH) <sub>4</sub> MoO <sub>4</sub>	232.1	SwHe71
MnF <sub>2</sub>	642.6	Aoki76, CSC72	Al <sub>2</sub> (MoO <sub>4</sub> ) <sub>3</sub>	232.5	PCLH76
			Al <sub>2</sub> (MoO <sub>4</sub> ) <sub>3</sub>	233.3	NFS82

CaMoO <sub>4</sub>	232.8	NFS82	VN	397.4	STAB76
CoMoO <sub>4</sub>	232.4	GPDG79, CiDe75, AMFL74	BN	398.1	WRDM79, HJGN70
CrMoO <sub>4</sub>	232.2	TVG76	Si <sub>3</sub> N <sub>4</sub>	397.4	TLR78
CuMoO <sub>4</sub>	232.7	HMUZ78	S <sub>2</sub> N <sub>2</sub>	398.9	SDIO77
K <sub>2</sub> MoO <sub>4</sub>	232.1	NFS82	SP(NH <sub>3</sub> ) <sub>3</sub>	398.8	FIWe75
Na <sub>2</sub> MoO <sub>4</sub>	232.1	CiDe75, NFS82, SwHe71, NSLS77	S <sub>4</sub> N <sub>3</sub> Cl (NPCL <sub>2</sub> ) <sub>3</sub>	400.4 400.3	HHJ69 HHJ69
Na <sub>2</sub> MoO <sub>4</sub> · 2H <sub>2</sub> O	232.5	GrMa75	Cs(N*NN*)	397.9	SGRS72
(NH <sub>4</sub> ) <sub>2</sub> Mo <sub>2</sub> O <sub>7</sub>	232.5	AMFL74	Cs(NN*N)	402.2	SGRS72
(NH <sub>4</sub> ) <sub>2</sub> Mo <sub>7</sub> O <sub>24</sub> · 4H <sub>2</sub> O	232.7	GrMa75	K(N*NN*)	398.5	SGRS72
Cu <sub>2</sub> Mo <sub>3</sub> O <sub>10</sub>	232.4	HMUZ78	K(NN*N)	402.8	SGRS72
Cu <sub>3</sub> Mo <sub>2</sub> O <sub>9</sub>	232.8	HMUZ78	Li(N*NN*)	398.7	SGRS72
Rh <sub>2</sub> MoO <sub>6</sub>	231.8	NFS82	Li(NN*N)	403.1	SGRS72
Cl <sub>2</sub> Mo(NO) <sub>2</sub>	230.4	Nefe78	Na(N*NN*)	398.5	SGRS72
K <sub>4</sub> Mo <sub>2</sub> Cl <sub>8</sub>	229.2	HUGH79	Na(N*NN*)	400.1	HHJ69
L <sub>4</sub> (Mo <sub>6</sub> I <sub>8</sub> )	228.8	BeWa79	Na(NN*N)	402.9	SGRS72
Br <sub>4</sub> (Mo <sub>6</sub> Br <sub>8</sub> )	229.3	BeWa79	Na(NN*N)	404.5	HHJ69
Cl <sub>4</sub> Mo(Ph <sub>3</sub> P) <sub>2</sub>	231.9	HuBa74	Rb(N*NN*)	398.1	SGRS72
Cl <sub>4</sub> Mo <sub>2</sub> (Et <sub>3</sub> P) <sub>4</sub>	228.7	Walt77	Rb(NN*N)	402.4	SGRS72
Cl <sub>3</sub> Mo(PhPMe <sub>2</sub> ) <sub>3</sub> mer	229.4	LeBr72	K <sub>3</sub> Co(CN) <sub>6</sub>	399.6	Vann76
Cl <sub>4</sub> Mo <sub>2</sub> (PhPMe <sub>2</sub> ) <sub>4</sub>	228.7	Walt77	K <sub>3</sub> Cr(CN) <sub>6</sub>	397.6	Vann76, ZeHa71
(CO) <sub>5</sub> Mo(Ph <sub>3</sub> P)	228.3	HVV79	K <sub>3</sub> Fe(CN) <sub>6</sub>	398.1	Vann76
(CO) <sub>4</sub> Mo(Ph <sub>3</sub> P) <sub>2</sub>	227.8	HuBa74	K <sub>3</sub> Mn(CN) <sub>6</sub>	398.3	Vann76
(CO) <sub>5</sub> Mo(Ph <sub>3</sub> P) <sub>3</sub>	227.4	HuBa74	K <sub>4</sub> Fe(CN) <sub>6</sub>	398.0	Vann76
Cl <sub>2</sub> Mo(CO) <sub>2</sub> (Ph <sub>3</sub> P) <sub>2</sub>	229.3	Nefe78	K <sub>4</sub> Fe(CN) <sub>6</sub>	397.8	YNNNA77
Cl <sub>2</sub> Mo(CO) <sub>3</sub> (Ph <sub>3</sub> P) <sub>2</sub>	228.8	HuBa74	K <sub>4</sub> V(CN) <sub>6</sub>	398.5	Vann76
Cl <sub>2</sub> Mo(NO) <sub>2</sub> (Ph <sub>3</sub> P) <sub>2</sub>	230.3	HuBa74	Na <sub>4</sub> Mn(CN) <sub>6</sub>	397.6	Vann76
Cl <sub>3</sub> Mo(NO) <sub>2</sub> (MeCN) <sub>2</sub>	231.5	Nefe78	Na <sub>2</sub> Fe(CN) <sub>3</sub> (N*O)	402.7	YNNNA77
Cl <sub>3</sub> Mo(pyridyl) <sub>3</sub>	229.5	CELC76	Na <sub>2</sub> Fe(CN*) <sub>3</sub> (NO)	397.4	YNNNA77
Cl <sub>4</sub> Mo <sub>2</sub> (pyridyl) <sub>4</sub>	228.9	Walt77	Na <sub>2</sub> Fe(CN) <sub>5</sub> N*O <sub>2</sub>	404.3	YNNNA77
Cl <sub>4</sub> Mo(pyridyl) <sub>2</sub>	230.8	SwHe71	Na <sub>2</sub> Fe(CN*) <sub>5</sub> NO <sub>2</sub>	396.6	YNNNA77
Br <sub>4</sub> (Mo <sub>6</sub> Br <sub>8</sub> )(pyridyl) <sub>2</sub>	229.7	BeWa79	KCN	399.8	HHJ69
Cl <sub>1</sub> Mo <sub>6</sub> (pyridyl)	229.6	HaWa74	KCN	398.3	YNNNA74
Cl <sub>4</sub> Mo(bipyridyl)	232.0	CELC76	KCN	400.6	Vann76
Cl <sub>3</sub> MoO(bipyridyl)	231.9	CELC76	NaCN	400.2	Vann76
Cl <sub>2</sub> MoO <sub>2</sub> (bipyridyl)	232.3	CELC76	(NH <sub>4</sub> ) <sub>2</sub> PtCl <sub>4</sub>	400.3	KaEI79
(CO) <sub>4</sub> Mo(bipyridyl)	226.3	GrMa75	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	401.3	SwAI74
Cl <sub>1</sub> Mo <sub>6</sub> (Ph <sub>3</sub> P) <sub>2</sub>	229.6	HaWa74	N*H <sub>4</sub> NO <sub>3</sub>	401.9	SwAI74, BCM78
Cl <sub>6</sub> (Mo <sub>6</sub> Br <sub>8</sub> )(Et <sub>4</sub> N) <sub>2</sub>	229.2	BeWa79	N*H <sub>4</sub> NO <sub>3</sub>	402.3	BTE77
Br <sub>6</sub> (Mo <sub>6</sub> Br <sub>8</sub> )(Et <sub>4</sub> N) <sub>2</sub>	229.3	BeWa79	N*H <sub>4</sub> NO <sub>3</sub>	403.1	HHJ69
(Bu <sub>3</sub> N) <sub>2</sub> Mo(CO) <sub>4</sub>	227.4	GrMa75	N <sub>2</sub> H <sub>6</sub> SO <sub>4</sub>	403.3	HHJ69
(Bu <sub>4</sub> N) <sub>2</sub> Mo <sub>4</sub> I <sub>11</sub>	229.0	BeWa79	N <sub>2</sub> H <sub>6</sub> SO <sub>4</sub>	401.7	Folk73
(Bu <sub>4</sub> N) <sub>3</sub> Mo <sub>2</sub> Cl <sub>9</sub>	229.5	Walt77	NH <sub>3</sub> OCl, ionic	402.9	HHJ69
(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> Mo(CO) <sub>3</sub>	227.4	GrMa75	NH <sub>3</sub> OCl, ionic	401.4	Folk73
MoO <sub>2</sub> (acac) <sub>2</sub>	232.0	GrMa75	NH <sub>3</sub> SO <sub>3</sub>	402.6	HHJ69
			NaN <sub>2</sub> O <sub>2</sub>	402.1	HHJ69
			KSCN	399.3	HHJ69
BN	398.1	Φ	KOCN	399.1	HHJ69
NH <sub>3</sub>	399.6	HHJ69	KOCN	397.9	Folk73
NH <sub>3</sub>	398.7	LaLu79, RNS73	NF <sub>4</sub> BF <sub>4</sub>	417.1	RNS73
Cr <sub>2</sub> N	397.4	RoRo76	NaNO <sub>2</sub>	404.9	HHJ69, LiHe75
CrN	396.7	STAB76	NaNO <sub>2</sub>	403.9	BTE77
GaN	397.0	HeMa80	Ba(NO <sub>3</sub> ) <sub>2</sub>	407.5	CLSW83
Ge <sub>3</sub> N <sub>4</sub>	397.4	TLR78	Ca(NO <sub>3</sub> ) <sub>2</sub>	408.0	CLSW83
ScN	396.2	STAB76	KNO <sub>3</sub>	407.2	NSLS77
TiN	396.9	STAB76	NH <sub>4</sub> N*O <sub>3</sub>	407.3	BTE77

## N 1s

BN	398.1	Φ	KOCN	399.1	HHJ69
NH <sub>3</sub>	399.6	HHJ69	KOCN	397.9	Folk73
NH <sub>3</sub>	398.7	LaLu79, RNS73	NF <sub>4</sub> BF <sub>4</sub>	417.1	RNS73
Cr <sub>2</sub> N	397.4	RoRo76	NaNO <sub>2</sub>	404.9	HHJ69, LiHe75
CrN	396.7	STAB76	NaNO <sub>2</sub>	403.9	BTE77
GaN	397.0	HeMa80	Ba(NO <sub>3</sub> ) <sub>2</sub>	407.5	CLSW83
Ge <sub>3</sub> N <sub>4</sub>	397.4	TLR78	Ca(NO <sub>3</sub> ) <sub>2</sub>	408.0	CLSW83
ScN	396.2	STAB76	KNO <sub>3</sub>	407.2	NSLS77
TiN	396.9	STAB76	NH <sub>4</sub> N*O <sub>3</sub>	407.3	BTE77

NH <sub>4</sub> N <sup>+</sup> O <sub>3</sub>	408.0	HHJ69	N(CH <sub>2</sub> COOH) <sub>3</sub>	398.70	YoSa74
NH <sub>4</sub> N <sup>+</sup> O <sub>3</sub>	405.8	BCM78	H <sub>2</sub> NCH <sub>2</sub> COOH	398.70	YoSa74
NaNO <sub>3</sub>	408.1	HHJ69, LiHe75	H <sub>3</sub> NCH <sub>2</sub> COO ionic	400.60	YoSa74
NaNO <sub>3</sub>	407.4	BTE77	EtCHNH <sub>2</sub> COOH	400.60	YNAB77
Ni(NO <sub>3</sub> ) <sub>2</sub>	407.0	TRLK73	H <sub>2</sub> N(CH <sub>2</sub> ) <sub>3</sub> COOH	398.80	YoSa74
Ni(NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	407.6	NZB78	CH <sub>3</sub> CHNH <sub>2</sub> COOH	401.00	YNAB77, KNPP74
Pb(NO <sub>3</sub> ) <sub>2</sub>	407.2	TLR78	H <sub>2</sub> NCONH <sub>2</sub>	399.50	LeRa77
Sr(NO <sub>3</sub> ) <sub>2</sub>	408.1	CLSW83	H <sub>2</sub> NCSNH <sub>2</sub>	399.80	SrWa77, NBMO73
K <sub>2</sub> Pt(NO <sub>2</sub> ) <sub>4</sub>	404.7	SNMK78	H <sub>2</sub> NCSNH <sub>2</sub>	399.20	LeRa77
K <sub>2</sub> Pt(NO <sub>2</sub> ) <sub>6</sub>	404.7	SNMK78	CH <sub>3</sub> CONH <sub>2</sub>	399.60	SNMK78
K <sub>3</sub> Co(NO <sub>2</sub> ) <sub>6</sub>	404.2	NBMO73	PhCONH <sub>2</sub>	399.50	LBNN78, HH 69
K <sub>3</sub> Rh(NO <sub>2</sub> ) <sub>6</sub>	404.1	SNMK78	PhN=NPh	399.60	BrFe76
K <sub>3</sub> Rh(NO <sub>3</sub> ) <sub>6</sub>	407.3	SNMK78	PhN=NPh	400.10	LiHe75
MoCl <sub>2</sub> (NO) <sub>2</sub>	401.4	Nefe78	PhCH=NPh	399.10	SZNS77
K <sub>2</sub> Os(NO)Cl <sub>5</sub>	402.8	Nefe78	1,1'-azonaphthalene	400.00	Yosh80
K <sub>2</sub> Ru(NO)I <sub>5</sub>	402.5	Nefe78	NCN=C(N <sup>+</sup> H <sub>2</sub> ) <sub>2</sub>	399.20	LeRa77
K <sub>2</sub> Ru(NO)Br <sub>5</sub>	403.30	Nefe78	AmONO	404.5	LiHe75
Rh <sub>3</sub> (NO) <sub>6</sub> Cl <sub>3</sub>	401.90	Nefe78	PhC=NOHC=NOHPh	400.6	Yosh78
Co(CO) <sub>3</sub> NO	402.20	BCGH72	MeC=NOHC=NOHMe	399.8	Yosh78
Fe(CO) <sub>2</sub> (NO) <sub>2</sub>	401.80	BCGH72	Ni(dimethylglyoxime) <sub>2</sub>	400.4	NZB78
Co(NH <sub>3</sub> ) <sub>5</sub> Cl <sub>3</sub>	400.10	YNAB77	Cu Salicylaldoxime	400.3	BuBu74
Ni(NH <sub>3</sub> ) <sub>6</sub> Br <sub>2</sub>	399.60	NZB 78	Cu(8-hydroxyquinol) <sub>2</sub>	399.5	YoSa74
Ni(NH <sub>3</sub> ) <sub>6</sub> (ClO <sub>4</sub> ) <sub>2</sub>	399.90	NZB 78	8-Quinolinol	398.9	Yosh80
Pt(N <sup>+</sup> H <sub>3</sub> ) <sub>2</sub> (NO <sub>2</sub> ) <sub>2</sub>	400.40	Nefe78, CMHL77	Cr(CO) <sub>5</sub> NH <sub>3</sub>	399.5	BCGH72
Pt(NH <sub>3</sub> ) <sub>2</sub> (N <sup>+</sup> O <sub>2</sub> ) <sub>2</sub>	404.40	Nefe78, CMHL77	N(EtO) <sub>3</sub> SiCl	400.5	GrHe77
Pt(NH <sub>3</sub> ) <sub>2</sub> Cl <sub>2</sub>	400.20	Nefe78, CMHL77	N(EtO) <sub>3</sub> SiH	399.8	GrHe77
Rh(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	400.10	Nefe78	Morphine	398.5	SCKK75
Me <sub>4</sub> NBr	401.40	SGCT74	Morphine H <sub>2</sub> SO <sub>4</sub>	401.2	SCKK75
Me <sub>4</sub> NCl	401.50	EMGK74			
Me <sub>4</sub> NCl	402.30	LiHe75	<b>Na 1s</b>		
Et <sub>4</sub> NCl	401.40	EMGK74	Na	1071.8	Φ
Et <sub>3</sub> NHCl	401.20	LiHe75	NaCl	1072.1	Φ
Et <sub>3</sub> NHSO <sub>4</sub>	401.80	EvRe81	Na	1071.8	BaSt75
Bu <sub>3</sub> N	398.90	LiHe75	Na	1071.4	KLMP73
BuNH <sub>3</sub> HSO <sub>4</sub>	401.00	EvRe81	NaI	1071.7	WRDM79
Bu <sub>4</sub> NHSO <sub>4</sub>	402.20	EvRe81	NaBr	1071.7	Wagn75
EtNH <sub>2</sub>	398.90	BCGH73	NaBr	1071.4	MVS73
EtNH <sub>2</sub> BF <sub>3</sub>	401.40	BCGH73	NaCl	1071.6	Wagn75
NH <sub>4</sub> Cl	400.80	SwAl74	NaCl	1072.5	SGS070
NH <sub>4</sub> Cl	401.50	EMGK74, BTE 77	NaCl	1071.5	KOK83
NH <sub>3</sub> BF <sub>3</sub>	401.90	BCGH73	NaCl	1071.8	NSLS77
C <sub>5</sub> H <sub>5</sub> N	398.80	LiHe75	NaCl	1072.3	HHDD81
C <sub>5</sub> H <sub>5</sub> N	399.30	BCGH73	NaF	1071.2	Wagn75
C <sub>5</sub> H <sub>5</sub> NHCl	401.00	HHJ 69	NaF	1071.0	MVS73, NSLS77
C <sub>5</sub> H <sub>5</sub> NBF <sub>3</sub>	401.40	BCGH73	Na <sub>2</sub> CO <sub>3</sub>	1071.5	WRDM79
Hexamethylenetetramm	399.40	LiHe75	Na <sub>2</sub> CO <sub>3</sub>	1071.7	HHDD81
PhCN	399.20	LiHe75	Na <sub>2</sub> HPO <sub>4</sub>	1071.6	WRDM79
C(NH <sub>2</sub> ) <sub>3</sub> Cl	400.10	LeRa77	Na <sub>2</sub> HPO <sub>4</sub>	1071.5	Swif82
PhNH <sub>2</sub>	399.40	LiHe75	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	1071.6	Wagn75
Me <sub>3</sub> NO	403.00	LiHe75	Na <sub>2</sub> SO <sub>3</sub>	1071.3	Wagn75
OP(NMe <sub>2</sub> ) <sub>3</sub>	399.10	FlWe75	Na <sub>2</sub> SO <sub>4</sub>	1071.2	Wagn75
P(NMe <sub>2</sub> ) <sub>3</sub>	398.30	GBMP79	Na <sub>2</sub> SeO <sub>3</sub>	1070.8	Wagn75
Cysteine HCl Hydrate	401.20	SSEW79	Na <sub>2</sub> TeO <sub>4</sub>	1071.1	Wagn75
Cysteine	400.00	LIMa79	Na <sub>3</sub> PO <sub>4</sub>	1071.1	MVS73, Swif82, GMD79
H <sub>3</sub> N(CH <sub>2</sub> ) <sub>3</sub> COOH ionic	400.80	YoSa74	Na <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	1070.8	MVS73
HN(CH <sub>2</sub> COOH) <sub>3</sub> ionic	400.70	YoSa74	Na <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	1071.6	GMD79

NaClO <sub>4</sub>	1071.8	MVS73	NaCl	990.1	KOK83
NaH <sub>2</sub> PO <sub>2</sub>	1071.1	Swif82	NaF	998.6	Wagn75
NaH <sub>2</sub> PO <sub>4</sub>	1072.0	Swif82	Na <sub>2</sub> CO <sub>3</sub>	989.8	WRDM79
NaHCO <sub>3</sub>	1071.3	WRDM79	Na <sub>2</sub> HPO <sub>4</sub>	989.9	WRDM79
NaN <sub>3</sub>	1070.8	SGRS72	Na <sub>2</sub> HPO <sub>4</sub>	989.7	Swif82
NaNO <sub>2</sub>	1071.6	Wagn75	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	990.1	Wagn75
NaNO <sub>3</sub>	1071.4	Wagn75	Na <sub>2</sub> SO <sub>3</sub>	990.4	Wagn75
NaPO <sub>3</sub>	1071.7	Wagn75	Na <sub>2</sub> SO <sub>4</sub>	989.8	Wagn75
NaPO <sub>3</sub>	1071.7	Swif82, GMD 79	Na <sub>2</sub> SeO <sub>3</sub>	991.0	Wagn75
Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	1071.6	WRDM79	Na <sub>2</sub> TeO <sub>4</sub>	990.5	Wagn75
Na <sub>2</sub> CrO <sub>4</sub>	1071.4	Wagn75	Na <sub>3</sub> PO <sub>4</sub>	990.1	Swif82
Na <sub>2</sub> CrO <sub>4</sub>	1071.0	ACHT73	NaH <sub>2</sub> PO <sub>2</sub>	989.8	Swif82
Na <sub>2</sub> IrCl <sub>6</sub>	1071.9	Wagn75	NaH <sub>2</sub> PO <sub>4</sub>	989.1	Swif82
Na <sub>2</sub> MoO <sub>4</sub>	1070.9	Wagn75	NaHCO <sub>3</sub>	989.8	WRDM79
Na <sub>2</sub> MoO <sub>4</sub>	1071.8	NSLS77	NaNO <sub>2</sub>	989.8	Wagn75
Na <sub>2</sub> PdCl <sub>4</sub>	1071.8	Wagn75	NaNO <sub>3</sub>	989.6	Wagn75
Na <sub>2</sub> SnO <sub>3</sub> · 3H <sub>2</sub> O	1071.1	WRDM79	NaPO <sub>3</sub>	989.3	Wagn75
Na <sub>2</sub> WO <sub>4</sub>	1072.0	Wagn75	NaPO <sub>3</sub>	989.4	Swif82
NaAsO <sub>2</sub>	1070.9	Wagn75	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	990.6	WRDM79
NaBiO <sub>3</sub>	1071.3	WRDM79	Na <sub>2</sub> CrO <sub>4</sub>	991.2	Wagn75
NaCrO <sub>2</sub>	1072.4	ACHT73	Na <sub>2</sub> IrCl <sub>6</sub>	989.2	Wagn75
Na <sub>2</sub> BeF <sub>4</sub>	1071.8	NKBP73	Na <sub>2</sub> MoO <sub>4</sub>	991.0	Wagn75
Na <sub>2</sub> GeF <sub>6</sub>	1071.7	Wagn75	Na <sub>2</sub> PdCl <sub>4</sub>	990.2	Wagn75
Na <sub>2</sub> SiF <sub>6</sub>	1071.7	Wagn75	Na <sub>2</sub> SnO <sub>3</sub> · 3H <sub>2</sub> O	990.3	WRDM79
Na <sub>2</sub> SiF <sub>6</sub>	1072.1	NSLS77	Na <sub>2</sub> WO <sub>4</sub>	989.6	Wagn75
Na <sub>2</sub> TaF <sub>7</sub>	1071.9	NKBP73	NaAsO <sub>2</sub>	990.7	Wagn75
Na <sub>2</sub> TiF <sub>6</sub>	1071.6	Wagn75	NaBiO <sub>3</sub>	990.9	WRDM79
Na <sub>2</sub> ZrF <sub>6</sub>	1071.5	Wagn75	Na <sub>2</sub> GeF <sub>6</sub>	998.1	Wagn75
Na <sub>3</sub> AlF <sub>6</sub>	1071.8	Wagn75	Na <sub>2</sub> SiF <sub>6</sub>	987.7	Wagn75
Na <sub>3</sub> TaF <sub>8</sub>	1071.8	NKBP73	Na <sub>2</sub> TiF <sub>6</sub>	988.5	Wagn75
NaBF <sub>4</sub>	1072.7	Wagn75	Na <sub>2</sub> ZrF <sub>6</sub>	988.7	Wagn75
NaBeF <sub>3</sub>	1071.9	NKBP73	Na <sub>3</sub> AlF <sub>6</sub>	988.0	Wagn75
NaTaF <sub>6</sub>	1071.7	NKBP73	NaBF <sub>4</sub>	987.1	Wagn75
Na <sub>2</sub> O	1072.5	BaSt75	Na <sub>2</sub> O	989.8	BaSt75
NaOOCH	1071.1	WRDM79	NaOOCH	989.8	WRDM79
Na <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	1070.8	WRDM79	Na <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	990.5	WRDM79
NaAlSi <sub>3</sub> O <sub>8</sub> , albite	1072.2	WPHK82	Mol Sieve A	988.8	WPHK82
Hydroxysodalite	1070.5	WPHK82	Mol Sieve X	988.4	WPHK82
Natrolite	1072.4	WPHK82	Mol Sieve Y	987.8	WPHK82
Mol Sieve A	1071.8	WPHK82	NaOAc	989.9	Wagn75
Mol Sieve X	1072.3	WPHK82	NaOOCCH <sub>2</sub> SH	990.4	WRDM79
Mol Sieve Y	1072.6	WPHK82	NaO <sub>3</sub> SPh	989.7	WRDM79
NaOAc	1071.1	Wagn75	<b>Nb 3d</b>		
NaOAc	1071.7	HHDD81	Nb	202.4	Φ
NaOOCCH <sub>2</sub> SH	1071.2	WRDM79	Nb	202.3	NyMa80
NaO <sub>3</sub> SPh	1071.3	WRDM79	Nb	202.2	MSC73, NSCP74, WRDM79
p-(NaOCOCMe=CH <sub>2</sub> )	1072.2	HHDD81	Nb	201.8	Bahl75
<b>Na KLL</b>			Nb <sub>3</sub> Te <sub>4</sub>	202.8	Bahl75
Na	994.3	BaSt75	NbTe <sub>4</sub>	203.8	Bahl75
Na	994.3	KLMP73	Nb <sub>3</sub> Sc <sub>4</sub>	203.0	Bahl75
Na	994.5	SRHH78	NbSe <sub>2</sub>	203.4	Bahl75
Nal	991.2	WRDM79	NbS <sub>2</sub>	207.7	MSC73
NaBr	990.6	Wagn75	NbN	203.8	Bahl75
NaCl	990.3	Wagn75	NbBr <sub>5</sub>	207.1	MSC73
NaCl	990.0	SGSO70	NbCl <sub>5</sub>	208.0	MSC73



NbO	202.8	SPB76	Ni <sub>2</sub> O <sub>3</sub>	855.8	KiWi74
NbO	203.7	Bahl75	Ni(OH) <sub>2</sub>	855.6	DPS77, LFWS79, McCo75
NbO	204.7	FCFG77	Ni(NO <sub>3</sub> ) <sub>2</sub>	857.1	TRLK73
Nb <sub>2</sub> O <sub>5</sub>	207.5	SPB76, MSC73, FCFG77, NFS82, NGDS75	Ni(NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	856.9	NZB78
LiNbO <sub>3</sub>	207.1	StHo79	NiAl <sub>2</sub> O <sub>4</sub>	855.8	SDR 80, LFWS79
KNbO <sub>3</sub>	206.5	MSC73	NiAl <sub>2</sub> O <sub>4</sub>	857.4	NgHe76
CaNb <sub>2</sub> O <sub>6</sub>	206.8	Bahl75	Ni <sub>2</sub> SiO <sub>4</sub>	856.1	LFWS79
CdNb <sub>2</sub> O <sub>6</sub>	207.0	Bahl75	NiClO <sub>4</sub> · 6H <sub>2</sub> O	857.2	NZB78
Ca <sub>2</sub> Nb <sub>2</sub> O <sub>7</sub>	206.7	Bahl75	NiFe <sub>2</sub> O <sub>4</sub>	855.4	McCo75
RhNbO <sub>4</sub>	206.5	NFS82	NiRh <sub>2</sub> O <sub>4</sub>	855.9	NFS82
Cl <sub>2</sub> Nb <sub>6</sub> Cl <sub>12</sub> (H <sub>2</sub> O) <sub>4</sub> · 4H <sub>2</sub> O	204.7	BeWa79	NiSO <sub>4</sub>	856.8	ShRe79
Cl <sub>6</sub> (Nb <sub>6</sub> Cl <sub>12</sub> )(Et <sub>4</sub> N) <sub>3</sub>	204.7	BeWa79	NiSiO <sub>3</sub>	856.5	SRD79
Br <sub>6</sub> (Nb <sub>6</sub> Cl <sub>12</sub> )(Bu <sub>4</sub> N) <sub>2</sub>	204.7	BeWa79	NiWO <sub>4</sub>	857.7	NgHe76
Cl <sub>2</sub> (Nb <sub>6</sub> Cl <sub>12</sub> )(Pr <sub>3</sub> P) <sub>4</sub>	204.6	BeWa79	NaNiIO <sub>6</sub> · H <sub>2</sub> O	856.4	NZB78
Cl <sub>2</sub> (Nb <sub>6</sub> Cl <sub>12</sub> )(Me <sub>2</sub> SO) <sub>4</sub>	204.6	BeWa79	K <sub>2</sub> NiF <sub>6</sub>	861.0	TRLK73
<b>Nd 3d</b>			Ni(CO) <sub>4</sub>	854.8	BCGH72
Nd	980.8	Φ	Br <sub>2</sub> Ni(NH <sub>3</sub> ) <sub>6</sub>	855.9	NZB78
Nd <sub>2</sub> O <sub>3</sub>	982.0	SaRa80	Ni(NH <sub>3</sub> ) <sub>6</sub> (ClO <sub>4</sub> ) <sub>2</sub>	856.5	NZB78
<b>Nd 4d</b>			Ni(acac) <sub>2</sub>	855.9	NZB78, TRLK73
Nd <sub>2</sub> O <sub>3</sub>	120.8	SaRa80	Ni(OAc) <sub>2</sub> · 4H <sub>2</sub> O	856.5	NZB78
<b>Ne 1s</b>			Ni(C <sub>5</sub> H <sub>5</sub> )	854.2	BCDH73
Ne in graphite	863.1	Φ	Ni(C <sub>5</sub> H <sub>5</sub> )	856.8	ClAd71, TRLK73
Ne in Ag	862.4	CiHa74	Cl <sub>2</sub> Ni(Ph <sub>3</sub> P) <sub>2</sub>	855.0	BNSA70
Ne in Au	861.6	CiHa74	Cl <sub>2</sub> Ni(Ph <sub>3</sub> P) <sub>2</sub>	854.4	NZB78
Ne in Cu	862.2	CiHa74	Cl <sub>2</sub> Ni(Ph <sub>3</sub> P) <sub>2</sub>	857.0	STHU76
Ne in Fe	863.4	Wagn75	Ni(dimethylglyoxim) <sub>2</sub>	855.0	NZB78, YoYa81
<b>Ne KLL</b>			Cl <sub>2</sub> Ni(bipyridyl)	855.7	NSWU77, NZB78
Ne in Fe	818.0	Wagn75	Ni(SPh) <sub>2</sub>	854.6	BBFR77
<b>Ni 2p</b>			Cl <sub>2</sub> Ni(NH <sub>3</sub> CONHCONH <sub>2</sub> ) <sub>2</sub>	856.7	YY878
Ni	852.7	Φ	Ni(2-aminobenzoate) <sub>2</sub>	855.9	YoYa81
NiO	853.8	Φ	Ni(P(OEt) <sub>3</sub> ) <sub>4</sub>	853.8	TRLK73
Ni	852.7	LANM81	Cl <sub>2</sub> Ni(Et <sub>3</sub> P) <sub>2</sub>	854.7	FaBa79
Ni	852.7	ALMP82	Br <sub>4</sub> Ni(Et <sub>4</sub> N) <sub>2</sub>	855.2	EMGK74
Ni	852.8	PEJ82	<b>Ni LMM</b>		
Ni	852.7	WRDM79, ShRe79	Ni	846.1	PEJ82
Ni <sub>3</sub> Yb	852.7	WWC78	Ni	846.2	WRDM79
Ni <sub>2</sub> Si	853.0	GGM82	Ni	846.1	KiWi74, KGW76
NiSi	853.5	GGM82	<b>O 1s</b>		
NiS	852.8	ShRe79	Al <sub>2</sub> O <sub>3</sub> , sapphire	531.0	Φ
NiS	853.2	DPS77	Ag <sub>2</sub> O	529.2	Scho73
NiS	855.1	NgHe76	AgO	528.6	Scho73, SRD80
NiI <sub>2</sub> · 6H <sub>2</sub> O	855.3	NZB78	Al <sub>2</sub> O <sub>3</sub>	531.3	Nefe82, SDR80,
NiCl <sub>2</sub>	856.7	TRLK73, KiHe83, YY878	Al <sub>2</sub> O <sub>3</sub> , sapphire	531.0	BGD75, ZSOS79
NiF <sub>2</sub> · 4H <sub>2</sub> O	857.5	NSLS77	Al <sub>2</sub> O <sub>3</sub> , alpha	531.8	Tayl82, WPHK82
NiO	853.5	WRDM79	Al <sub>2</sub> O <sub>3</sub> , gamma	530.9	Barr83, WPHK82
NiO	854.3	DPS77, KiHe83, LFWS79, NFS82, NZB78, SRD79	As <sub>2</sub> O <sub>3</sub>	531.7	Tayl82, MINN78
NiO	854.3	KiWi74, McCo75	As <sub>2</sub> O <sub>5</sub>	531.6	WZR80
Ni <sub>2</sub> O <sub>3</sub>	857.3	NgHe76	B <sub>2</sub> O <sub>3</sub>	533.0	NGDS75
			BaO	528.3	InYa81
			BeO	531.7	NGDS75, NFS75, HJGN70
			Bi <sub>2</sub> O <sub>3</sub>	530.0	NGDS75, DSBG82
			CaO	529.4	InYa81

CaO	531.3	WZR80	Nb <sub>2</sub> O <sub>5</sub>	530.6	NGDS75, NFS82
CdO	529.2	NFS75, NGDS75, SBB80	Nb <sub>2</sub> O <sub>5</sub>	531.3	SaRa80
CdO <sub>2</sub>	530.3	HGW75	NbO <sub>2</sub>	530.7	SaRa80
Ce <sub>2</sub> O <sub>3</sub>	530.3	PKHL80	Nd <sub>2</sub> O <sub>3</sub>	530.6	SaRa80
CeO <sub>2</sub>	529.2	NGDS75	Ni <sub>2</sub> O <sub>3</sub>	531.8	KiWi74, NgHe76
Co <sub>2</sub> O <sub>3</sub>	529.9	McCo75	NiO	529.6	DPS77, LFWS79, NFS82, NGDS75, SRD79, WZR80
Co <sub>3</sub> O <sub>4</sub>	530.2	NGDS75, WZR80	P <sub>2</sub> O <sub>5</sub> (bridging O)	532.2	NGDS75
Co <sub>3</sub> O <sub>4</sub>	529.6	BGD75	P <sub>2</sub> O <sub>5</sub> (bridging O)	532.6	GMD79
Co <sub>3</sub> O <sub>4</sub>	529.7	CBR76, GPDG79, HSU76	P <sub>2</sub> O <sub>5</sub> (nonbridging O)	533.6	NGDS75
CoO	530.1	BGD75, NFS82, NGDS75	P <sub>2</sub> O <sub>5</sub> (nonbridging O)	534.3	GMD79
Cr <sub>2</sub> O <sub>3</sub>	531.0	HoTh80, DPS76, WZR80, BDFFP81	PbO	528.9	NFS82
Cr <sub>2</sub> O <sub>3</sub>	531.5	NGDS75	PbO	531.6	WZR80
CrO <sub>2</sub>	529.3	IICK76	PbO, rhombic	529.4	KOW73
CrO <sub>3</sub>	530.2	DPS76	PbO, rhombic	530.9	ZiHe78
CsO <sub>2</sub>	527.5	YaBa80	PbO, tetragonal	527.5	KOW73
Cs <sub>2</sub> O <sub>4</sub>	530.5	YaBa80	PbO, tetragonal	528.9	ZiHe78
Cu <sub>2</sub> O	530.3	HMUZ78, MSSS81, RBO72, Scho73b	PbO <sub>2</sub>	527.4	KOW73
CuO	529.6	MSSS81, McCo75, HMUZ78, RBO72, Scho73b	PbO <sub>2</sub>	529.0	TLR78
Fe <sub>2</sub> O <sub>3</sub>	530.2	NGDS75, WZR80, Kilk73, Limo81	Pt <sub>2</sub> O <sub>3</sub>	529.3	SaRa80
Fe <sub>2</sub> O <sub>3</sub>	529.6	HSU76, NSLS77	PrO <sub>2</sub>	528.6	SaRa80
Fe <sub>2</sub> O <sub>3</sub> , alpha	529.6	McZe77	PtO <sub>2</sub>	531.4	CMHL77
Fe <sub>2</sub> O <sub>3</sub> , gamma	529.8	McZe77	ReO <sub>2</sub>	530.1	BHU81
Fe <sub>3</sub> O <sub>4</sub>	530.0	McZe77	ReO <sub>3</sub>	531.9	BHU81
FeO	529.8	McZe77	Rh <sub>2</sub> O <sub>3</sub>	530.4	CMHL77, NFS82
Ga <sub>2</sub> O <sub>3</sub>	530.8	NGDS75, Scho73a, WZR80, ZSOS79	RuO <sub>2</sub>	529.4	MWLF78
GeO <sub>2</sub>	520.0	NGDS75, WZR80	RuO <sub>3</sub>	530.7	KiWi74
H <sub>2</sub> O	533.2	NGDS75, WZR80	Sb <sub>2</sub> O <sub>3</sub>	530.0	WZR80
HfO <sub>2</sub>	530.4	NGDS75	Sc <sub>2</sub> O <sub>3</sub>	530.0	NGDS75, WZR80
I <sub>2</sub> O <sub>5</sub>	529.9	Sher76	SiO <sub>2</sub>	533.0	Barr83, KMH78, NGDS75
In <sub>2</sub> O <sub>3</sub>	529.8	NGDS75	SiO <sub>2</sub>	534.3	Kilk73
In <sub>2</sub> O <sub>3</sub>	530.3	CFRS80	SiO <sub>2</sub> , gel	532.5	NSLS77, SRD79
In <sub>2</sub> O <sub>3</sub>	530.5	LAK77	SiO <sub>2</sub> , Vycor	532.8	WPHK82
La <sub>2</sub> O <sub>3</sub>	528.6	NGDS75	SiO <sub>2</sub> , alpha cristobal	532.9	WPHK82
Li <sub>2</sub> O	531.3	CSFG79	SiO <sub>2</sub> , alpha quartz	532.5	WPHK82
Lu <sub>2</sub> O <sub>3</sub>	529.5	NGDS75	SiO <sub>2</sub> , alpha quartz	532.7	WPHK82
MgO	530.0	NFS82, NGDS75	SnO	533.2	TLR78
MgO	531.2	InYa81	SnO <sub>2</sub>	530.1	ADPS77
MgO	532.1	WZR80		530.6	ADPS77, LAK77, MWLF78, NGDS75, TLR78
MnO	529.7	OHI75	SrO	530.5	VaVe80
Mn <sub>3</sub> O <sub>4</sub>	529.6	OHI75	Tb <sub>2</sub> O <sub>3</sub>	528.8	SaRa80
Mn <sub>2</sub> O <sub>3</sub>	529.6	OHI75	TbO <sub>2</sub>	528.8	SaRa80
MnO <sub>2</sub>	530.0	NGDS75, WZR80	TeO <sub>2</sub>	530.2	GBP81, SBB80
MnO <sub>2</sub> , beta	529.6	OHI75	ThO <sub>2</sub>	530.0	NGDS75
MoO <sub>2</sub>	531.1	PCLH76	TiO <sub>2</sub>	529.9	MWLF78, WZR80, NGDS75
MoO <sub>2</sub>	530.7	CGR78, KBAW74	UO <sub>2</sub>	530.4	MSSS81
MoO <sub>2</sub>	529.9	SaRa80	UO <sub>3</sub>	529.9	MSSS81
MoO <sub>3</sub>	530.9	NGDS75, NFS82	V <sub>2</sub> O <sub>3</sub>	530.5	CGR78
MoO <sub>3</sub>	531.6	PCLH76	V <sub>2</sub> O <sub>4</sub>	530.0	KKL83
MoO <sub>3</sub>	530.4	SaRa80, KBAW74, HMUZ78, CGR78	V <sub>2</sub> O <sub>5</sub>	529.9	BCM78, KKL83
Na <sub>2</sub> O	529.7	BaSt75	V <sub>2</sub> O <sub>5</sub>	530.5	NSLS77, NGDS75, NFS82
Nb <sub>2</sub> O <sub>5</sub>	529.6	GBP81	WO <sub>2</sub>	530.4	CoRa76

WO <sub>3</sub>	530.6	CoRa76, KMH78, NFS82, NGDS75, NSLS77	Na <sub>2</sub> CO <sub>3</sub>	531.6	HHDD8I, WZR80	
ZnO	530.4	NFS82, NGDS75, NSLS77, Scho73, WZR80, ZSOS79	PbCO <sub>3</sub>	531.2	WZR80	
ZrO <sub>2</sub>	530.2	NGDS75	CsClO <sub>4</sub>	532.7	MVS73	
ZrO <sub>2</sub>	530.9	WZR80	KClO <sub>4</sub>	532.2	MVS73	
Al(OH) <sub>3</sub> , bayerite	531.4	WPHK82	KClO <sub>3</sub>	532.3	MVS73	
Al(OH) <sub>3</sub> , gibbsite	531.5	WPHK80	LiClO <sub>4</sub>	533.4	MVS73	
AlOOH, boehmite	531.5	Tayl82	NaClO <sub>4</sub>	533.0	MVS73	
Co(OH) <sub>2</sub>	531.2	HSU76	RbClO <sub>4</sub>	532.8	MVS73	
Cr(OH) <sub>3</sub>	531.2	DPS76	Al <sub>2</sub> SiO <sub>5</sub> , kyanite	531.3	AnSw74	
Cu(OH) <sub>2</sub>	531.2	MSSS81	Al <sub>2</sub> SiO <sub>5</sub> , mullite	531.6	AnSw74	
Fe(OH) <sub>2</sub>	531.3	HSU76	Al <sub>2</sub> SiO <sub>5</sub> , sillimanite	531.3	AnSw74	
FeO*OH	530.1	McZe77	Al <sub>2</sub> SiO <sub>5</sub> , sillimanite	531.9	WPHK82	
FeOO*H	531.2	McZe77	Ca <sub>3</sub> (HSiO <sub>4</sub> ) <sub>2</sub>	531.2	CIRi76	
In(OH) <sub>3</sub>	531.8	WZR80	Co <sub>2</sub> SiO <sub>4</sub>	531.6	WZR80	
KOH	531.8	Kilk73	Na <sub>2</sub> SiO <sub>3</sub> · 5H <sub>2</sub> O*	530.6	CIRi76	
LiOH	531.2	CSFG79, WZR80	Na <sub>2</sub> SiO <sub>3</sub> · 5H <sub>2</sub> O*	532.5	CIRi76	
Mg(OH) <sub>2</sub>	530.9	HNUW78	Ni <sub>2</sub> SiO <sub>4</sub>	531.9	LFWS79	
NaOH	532.8	BaSt75	NiSiO <sub>3</sub>	532.3	SRD79	
Ni(OH) <sub>2</sub>	531.3	LFWS79	MgSiO <sub>3</sub> · 2H <sub>2</sub> O	532.0	CIRi76	
AlPO <sub>4</sub>	532.8	CFRS80	MgSiO <sub>3</sub> · 2H <sub>2</sub> O*	532.8	CIRi76	
Cs <sub>3</sub> PO <sub>4</sub>	530.1	MVS73	Al <sub>2</sub> (MoO <sub>4</sub> ) <sub>3</sub>	531.0	PCLH76	
Cs <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	530.2	MVS73	Al <sub>2</sub> (WO <sub>4</sub> ) <sub>3</sub>	532.0	NgHe76	
K <sub>3</sub> PO <sub>4</sub>	530.4	MVS73	CaCrO <sub>4</sub>	529.5	ACHT73	
K <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	530.1	MVS73	CaMoO <sub>4</sub>	530.6	NFS82	
Li <sub>3</sub> PO <sub>4</sub>	531.5	MVS73	CaWO <sub>4</sub>	529.9	NFS82	
Li <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	531.7	MVS73	p-Benzquinone	532.2	OYK74	
Na <sub>3</sub> PO <sub>4</sub>	530.4	MVS73, GMD79	Hydroquinone	533.5	OYK74	
Na <sub>4</sub> P <sub>2</sub> O <sub>7</sub> (bridging O)	531.1	GMD79	PhCOONa	531.4	LBNN78	
Na <sub>4</sub> P <sub>2</sub> O <sub>7</sub> (nonbridging O)	532.9	GMD79	p(Me <sub>2</sub> Si(O))	532.5	WPHK82	
Na <sub>3</sub> PO <sub>3</sub> (bridging O)	531.5	GMD79	Methylsilicone Resin	532.7	WPHK82	
Na <sub>3</sub> PO <sub>3</sub> (nonbridging O)	533.4	GMD79	Phenylsilicone Resin	532.6	WPHK82	
Ba(NO <sub>3</sub> ) <sub>2</sub>	533.0	CLSW83	PhCONH <sub>2</sub>	532.2	LBNN78	
Ca(NO <sub>3</sub> ) <sub>2</sub>	533.6	CLSW83	<b>Os 4f</b>			
KNO <sub>3</sub>	532.7	NSLS77	Os	50.7	Φ	
Pb(NO <sub>3</sub> ) <sub>2</sub>	532.7	TLR78	Os	50.6	Folk73, BNMMN79	
BaSO <sub>4</sub>	531.8	CLSW83	Os	50.2	BHHK70	
BaSO <sub>4</sub>	532.5	WZR80	OsCl <sub>3</sub>	53.1	Nefe78	
CaSO <sub>4</sub>	532.0	CLSW83, WZR80	OsO <sub>2</sub>	52.0	SaRa80	
Cr <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	532.1	DPS76	OsO <sub>2</sub>	52.7	Folk73	
FeSO <sub>4</sub>	532.4	Limo81	Os(HSO <sub>3</sub> ) <sub>2</sub>	52.2	Nefe78	
K <sub>2</sub> SO <sub>4</sub>	531.2	WZR80	K <sub>2</sub> OsI <sub>6</sub>	51.9	Nefe78	
NiSO <sub>4</sub>	532.1	NSLS77, Nefe82	K <sub>2</sub> OsBr <sub>6</sub>	52.9	Nefe78	
PbSO <sub>4</sub>	531.5	ZiHe78	K <sub>2</sub> OsCl <sub>6</sub>	53.0	Folk73	
ZnSO <sub>4</sub>	532.5	Nefe82	K <sub>2</sub> OsCl <sub>6</sub>	53.2	CoHe72	
Na <sub>2</sub> SO <sub>3</sub>	531.2	WZR80	K <sub>2</sub> OsCl <sub>6</sub>	53.5	LeBr72	
Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	531.8	WZR80	K <sub>2</sub> OsCl <sub>6</sub>	53.9	Nefe78	
PbSO <sub>3</sub>	530.8	ZiHe78	K <sub>2</sub> OsO <sub>2</sub> (OH) <sub>4</sub>	55.2	Nefe78	
PhS <sub>2</sub> O <sub>3</sub>	531.1	ZiHe78	Os(NH <sub>3</sub> ) <sub>5</sub> N <sub>2</sub> I <sub>2</sub>	50.9	Folk73	
Ag <sub>2</sub> CO <sub>3</sub>	530.6	HGW75	Os(NH <sub>3</sub> ) <sub>5</sub> N <sub>2</sub> Br <sub>2</sub>	52.0	Folk73	
BaCO <sub>3</sub>	531.3	CLSW83	Os(NH <sub>3</sub> ) <sub>4</sub> (N <sub>2</sub> ) <sub>2</sub> Br <sub>2</sub>	51.6	Folk73	
CaCO <sub>3</sub>	531.4	CLSW83, WZR80	Os(NH <sub>3</sub> ) <sub>5</sub> N <sub>2</sub> Cl <sub>2</sub>	52.2	Folk73	
CdCO <sub>3</sub>	531.4	HGW75	K <sub>2</sub> Os(NO)Br <sub>5</sub>	53.3	Nefe78	
CuCO <sub>3</sub>	531.5	WZR80	K <sub>2</sub> Os(NO)Cl <sub>5</sub>	53.4	Nefe78	
Li <sub>2</sub> CO <sub>3</sub>	531.5	CSFG79	HOs(Ph <sub>3</sub> P)Cl(CO)	51.1	Nefe78	
			OsCl <sub>4</sub> (Et <sub>3</sub> P) <sub>2</sub>	52.6	LeBr72	

OsCl <sub>4</sub> (PhPMc <sub>2</sub> ) <sub>2</sub> trans	53.0	LeBr72	(PhO) <sub>3</sub> PS	134.7	MSAV71
OsCl <sub>3</sub> (PhPMc <sub>2</sub> ) <sub>3</sub> mer	51.7	LeBr72	(PhO) <sub>3</sub> PSe	134.3	MSAV71
OsCl <sub>2</sub> (PhPMc <sub>2</sub> ) <sub>4</sub> trans	50.5	LeBr72	(PhO) <sub>3</sub> PO	133.6	CFRS80
<b>P 2p</b>					
P	129.9	Φ	Ph <sub>3</sub> POBBr <sub>3</sub>	133.7	HVV79
P	130.0	NSDU75	Ph <sub>3</sub> POBCl <sub>3</sub>	133.4	HVV79
P (red)	130.0	ScBr81	Ph <sub>3</sub> POBF <sub>3</sub>	133.3	HVV79
Cu <sub>3</sub> P	129.6	NSDU75	Ph <sub>2</sub> PO(OH)	133.3	MSAV71
CuP <sub>2</sub>	129.7	NSDU75	OPCl(OEt) <sub>2</sub>	134.8	FlWe75
GaP	128.8	WaTa80, IMNN79, NIMN78	OPF <sub>2</sub> NPh <sub>2</sub>	135.8	FlWe75
GaP, anodically oxid.	128.5	MIN81	OPCl <sub>2</sub> OEt	135.2	FlWe75
GaP, thermally oxid.	129.7	MIN81	OP(NMe <sub>2</sub> ) <sub>3</sub>	133.4	FlWe75
InP	128.3	CFRS80	Ph <sub>4</sub> PI	133.0	HVV79
InP	129.4	Bert81	Ph <sub>4</sub> PBr	133.5	LMF80, SRH72
Zn <sub>3</sub> P <sub>2</sub>	128.3	NSDU75	Ph <sub>4</sub> PCI	132.8	HVV79
ZnP <sub>2</sub>	129.8	NSDU75	MePPh <sub>3</sub> Br	133.0	SRH 2
AlPO <sub>4</sub>	132.9	CFRS80	(Ph <sub>3</sub> P) <sub>3</sub> P*F <sub>6</sub>	136.7	LMF80
Cs <sub>3</sub> PO <sub>4</sub>	132.1	MVS73	(Ph <sub>3</sub> P*) <sub>3</sub> PF <sub>6</sub>	133.5	LMF80
K <sub>2</sub> HPO <sub>4</sub>	132.8	Bert81	Pt(Ph <sub>3</sub> P) <sub>4</sub>	131.2	Rigg72
K <sub>3</sub> PO <sub>4</sub>	133.2	MVS73	Ph <sub>3</sub> P=CHCOPh	132.2	Dale76, STA74
Li <sub>3</sub> PO <sub>4</sub>	133.6	MVS73	Ph <sub>3</sub> P=CHCOOMe	132.5	STA74
Na <sub>2</sub> HPO <sub>4</sub>	133.1	Swif82, WRDM79, WaTa80	Cl <sub>2</sub> Ni(Ph <sub>3</sub> P) <sub>2</sub>	132.4	BNSA70
Na <sub>3</sub> PO <sub>4</sub>	132.4	MVS73, GMD79, Swif82	Ni(CO) <sub>2</sub> (Ph <sub>3</sub> P) <sub>2</sub>	131.4	TRLK73
NaH <sub>2</sub> PO <sub>4</sub>	134.2	Swif82	<b>Pb 4f</b>		
NaPO <sub>3</sub>	134.2	Swif82, GMD79	Pb	136.9	Φ
Rb <sub>3</sub> PO <sub>4</sub>	132.5	MVS73	Pb	136.4	LKMP73
NaH <sub>2</sub> PO <sub>2</sub>	132.6	Swif82	Pb	136.8	SFS77
Cs <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	132.6	MVS73	Pb	136.8	BeFl80, KOW73, KiWi73, TLR78, WRDM79, WaTa80
K <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	132.6	MVS73	Pb	136.8	HSBS81, OCH79
Li <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	134.3	MVS73	Pb	136.8	HSBS81
Na <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	133.2	MVS73, GMD79, Bert81	Pb <sub>98</sub> Sn <sub>2</sub>	136.8	SFS77
Rb <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	133.1	MVS73	PbTe	137.4	SFS77
P <sub>4</sub> O <sub>10</sub>	135.3	NIMN78, NGDS75, CFRS80, Bert81, GMD79	PbSe	137.4	SFS77
OPCl <sub>3</sub>	135.7	FlWe75	PbS	137.6	MoVa73, SFS77, ZiHe78
SPCl <sub>3</sub>	135.3	FlWe75	PbI <sub>2</sub>	138.7	MoVa73
SP(NH <sub>3</sub> ) <sub>3</sub>	133.4	FlWe75	PbBr <sub>2</sub>	138.8	NeFe82
Ph <sub>3</sub> P	130.9	Dale76, NSMS79, TRLK73, GBMP79	PbF <sub>2</sub>	139.0	MoVa73
Ph <sub>3</sub> P	130.9	HVV79, LMF80, SRH72	PbO	138.9	KOW73, ZiHe78, WRDM79, NFS82, NSSP80, MoVa73
Ph <sub>3</sub> P	130.9	MSAV71, GZF73	PbO	138.9	MoVa73, BeFl80
Ph <sub>3</sub> PS	132.5	HVV79, STA74, FlWe75, MSAV71	Pb <sub>3</sub> O <sub>4</sub>	138.0	MoVa73
Ph <sub>3</sub> PS	132.5	HVV79, STA74, FlWe75, MSAV71	PbO <sub>2</sub>	137.4	BeFl80, KOW73, TLR78, MoVa73
Ph <sub>3</sub> PSe	132.6	HVV79, MSAV71	Pb(OH) <sub>2</sub>	138.4	NSSP80
Ph <sub>3</sub> PO	132.5	GZF73, STA74, FlWe75, MSAV71, HVV79, BNSA70	Pb(NO <sub>3</sub> ) <sub>2</sub>	139.3	BeFl80, TLR78, NSSP80
Ph <sub>3</sub> PBI <sub>3</sub>	132.2	HVV79	PbSO <sub>3</sub>	138.6	ZiHe78
Ph <sub>3</sub> PBB <sub>3</sub>	132.1	HVV79	PbSO <sub>4</sub>	139.4	NSSP80, ZiHe78
Ph <sub>3</sub> PBCl <sub>3</sub>	132.2	HVV79	PbS <sub>2</sub> O <sub>3</sub>	138.4	ZiHe78
Ph <sub>3</sub> PBF <sub>3</sub>	132.0	HVV79	PbRh <sub>2</sub> O <sub>4</sub>	137.3	NFS82
Ph <sub>2</sub> PSH	132.3	NSWM80	Ph <sub>4</sub> Pb	138.2	MoVa73
Ph <sub>2</sub> PSeH	132.3	NSWM80	Ph <sub>3</sub> PbCl	138.9	MoVa73
(PhS) <sub>3</sub> P	134.3	MSAV71	Ph <sub>2</sub> PbCl <sub>2</sub>	139.4	MoVa73
(PhS) <sub>3</sub> PS	133.1	MSAV71	Pb(OAc) <sub>2</sub>	138.5	BeFl80
(PhO) <sub>3</sub> P	134.7	MSAV71	Pb(OAc) <sub>4</sub>	137.2	BeFl80

**Pd 3d**

Pd	335.1	Φ	Pr <sub>2</sub> O <sub>3</sub>	116.1	SaRa80
Pd	335.1	NyMa80	PrO <sub>2</sub>	116.2	SaRa80
Pd	335.2	BiSw80			
Pd	335.2	BiSw80	Pt	71.2	Φ
Pd	335.5	BiSw80	Pt	71.0	JHBK73
Pd	335.2	JHBK73, Asam76	Pt	71.2	BHHK70, KWD71, Nefe78,
Pd	335.3	WRDM79, WeAn80, BHHK70, Scho72, GGM82, KBAM72	Pt	71.2	Scho72, WRDM79, Wagn75, CMHL77, CaLe73, HaWi77, BACB75
Ag <sub>3</sub> OPd <sub>3</sub> O	334.6	WeAn80	Pt	71.2	GGM82
Ag <sub>3</sub> OPd <sub>3</sub> O	334.9	WeAn80	PtSi	73.0	GGM82
Ag <sub>3</sub> OPd <sub>3</sub> O	334.9	WeAn80	Pt <sub>2</sub> Si	72.5	EPCC75
Al <sub>8</sub> OPd <sub>2</sub> O	337.4	WeAn80	PtCl <sub>2</sub>	73.6	EPCC75
Mg <sub>75</sub> Pd <sub>25</sub>	336.2	WeAn80	PtCl <sub>4</sub>	75.5	EPCC75
Pd <sub>2</sub> Si	336.8	GGM82	PtO	73.8	KWD71
Pd <sub>3</sub> Si	336.2	AWL80	PtO	74.2	EPCC75
PdI <sub>2</sub>	336.4	KBAM72	PtO <sub>2</sub>	74.6	KWD71
PdBr <sub>2</sub>	337.1	KBAM72	PtO <sub>2</sub>	75.0	EPCC75
PdCl <sub>2</sub>	337.8	KBAM72, NKP73	Pt(OH) <sub>2</sub>	72.6	HaWi77
PdO	336.3	KGW74	K <sub>2</sub> PtI <sub>6</sub>	73.4	SNMK78
PdO <sub>2</sub>	337.9	KGW74	K <sub>2</sub> PtBr <sub>6</sub>	72.6	SNMK78
Na <sub>2</sub> PdCl <sub>4</sub>	338.0	SeTs76	K <sub>2</sub> PtBr <sub>6</sub>	74.6	SNMK78
K <sub>2</sub> PdCl <sub>4</sub>	338.2	KBAM72, NKP73	K <sub>2</sub> PtCl <sub>4</sub>	73.0	CMHL77, EPCC75, SNMK78
K <sub>2</sub> PdBr <sub>4</sub>	337.3	KBAM72	K <sub>2</sub> PtCl <sub>4</sub>	73.4	Wagn75
K <sub>2</sub> Pd(NO <sub>2</sub> ) <sub>4</sub>	339.0	KBAM72	K <sub>2</sub> PtCl <sub>4</sub>	73.4	CoHe72, EPCC75, LeBr72,
K <sub>2</sub> PdCl <sub>6</sub>	340.2	KBAM72, Nefe78	K <sub>2</sub> PtCl <sub>6</sub>	75.4	SNMK78
Br <sub>2</sub> Pd(Ph <sub>3</sub> P) <sub>2</sub>	337.8	KBAM72	K <sub>2</sub> PtF <sub>6</sub>	77.6	SNMK78
Cl <sub>2</sub> Pd(Ph <sub>3</sub> P) <sub>2</sub>	337.8	KBAM72, NSMS79	Pt(NH <sub>3</sub> ) <sub>4</sub> Br <sub>2</sub>	73.4	Nefe78
I <sub>2</sub> Pd(Ph <sub>3</sub> P) <sub>2</sub>	337.5	KBAM72	Pt(NH <sub>3</sub> ) <sub>2</sub> Cl <sub>2</sub>	73.2	CMHL77, Nefe78
(CN) <sub>2</sub> Pd(Ph <sub>3</sub> P) <sub>2</sub>	338.2	KBAM72	Pt(NH <sub>3</sub> ) <sub>4</sub> Cl <sub>2</sub>	73.4	SNMK78
Pd <sub>2</sub> (Ph <sub>3</sub> P) <sub>2</sub>	336.6	NSMS79	Pt(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>4</sub>	76.3	SNMK78
Cl <sub>2</sub> Pd(Ph <sub>3</sub> P) <sub>3</sub>	342.9	BNSA70	Pt(NH <sub>3</sub> ) <sub>2</sub> (NO <sub>2</sub> ) <sub>2</sub>	73.7	CMHL77
Pd(Ph <sub>3</sub> P) <sub>4</sub>	336.0	NSMS79	Pt(NH <sub>3</sub> ) <sub>2</sub> (NO <sub>2</sub> ) <sub>2</sub>	74.4	Nefe78
Pd(OAc) <sub>2</sub>	338.6	NSMS79	K <sub>2</sub> Pt(OH) <sub>6</sub>	75.1	SNMK78
Pd(SPh) <sub>2</sub>	337.7	BBFR77	K <sub>2</sub> Pt(NO <sub>2</sub> ) <sub>4</sub>	74.1	SNMK78

**Pd MNN**

Pd	327.8	WeAn80, WRDM79	(NH <sub>4</sub> ) <sub>2</sub> PtCl <sub>4</sub>	72.4	KaEl79
Ag <sub>3</sub> OPd <sub>3</sub> O	328.8	WeAn80	Pt(Ph <sub>3</sub> P) <sub>3</sub>	71.4	Nefe78
Ag <sub>3</sub> OPd <sub>3</sub> O	329.8	WeAn80	Pt(Ph <sub>3</sub> P) <sub>4</sub>	71.4	Rigg72
Ag <sub>3</sub> OPd <sub>3</sub> O	329.7	WeAn80	Cl <sub>2</sub> Pt(Ph <sub>3</sub> P) <sub>2</sub> cis	72.3	CAB71
Al <sub>8</sub> OPd <sub>2</sub> O	325.5	WeAn80	Cl <sub>2</sub> Pt(Ph <sub>3</sub> P) <sub>2</sub> cis	73.0	Rigg72
Mg <sub>75</sub> Pd <sub>25</sub>	326.4	WeAn80	Cl <sub>4</sub> Pt(Et <sub>3</sub> P) <sub>2</sub>	75.3	LeBr72
			Cl <sub>4</sub> Pt(Et <sub>3</sub> P) <sub>2</sub>	75.9	Nefe78, Rigg72
			HClPt(Et <sub>3</sub> P) <sub>2</sub>	72.6	Rigg72
			O <sub>2</sub> Pt(Ph <sub>3</sub> P) <sub>2</sub>	73.0	Rigg72
			Pt(SPh) <sub>2</sub>	72.8	BBFR77

**Pm 3d**

PmCl <sub>3</sub>	1033.5	MNTB70
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**Pm 4d**

PmCl <sub>3</sub>	128.3	MNTB70
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**Pr 3d**

Pr	931.8	Φ	I <sub>2</sub> Pt(Me <sub>3</sub> P) <sub>2</sub> trans	72.7	CAB71
Pr <sub>2</sub> O <sub>3</sub>	933.2	SaRa80	I <sub>2</sub> Pt(CH <sub>3</sub> CONH) <sub>4</sub>	74.6	NeSa78
PrO <sub>2</sub>	935.3	SaRa80	Br <sub>2</sub> Pt(CH <sub>3</sub> CONH) <sub>4</sub>	74.9	NeSa78
			Cl <sub>2</sub> Pt(CH <sub>3</sub> CONH) <sub>4</sub>	74.8	NeSa78

Cl <sub>2</sub> Pt(H <sub>2</sub> NCH <sub>2</sub> CH <sub>2</sub> NH <sub>2</sub> ) <sub>2</sub>	73.0	YMK78	Rh <sub>2</sub> WO <sub>6</sub>	309.4	NFS82
Cl <sub>2</sub> Pt(cyclooctadien)	73.9	CMHL77	RhNbO <sub>4</sub>	309.2	NFS82
K <sub>2</sub> PtCl <sub>6</sub>	318.1	EPCC75	RhTaO <sub>4</sub>	309.5	NPS82
Pt MNN			RhVO <sub>4</sub>	309.2	NFS82
Pt	1960.7	Wagn78	K <sub>3</sub> RhCl <sub>6</sub>	309.8	SNMK78
Pt	2041.1	Wagn78	K <sub>3</sub> RhF <sub>6</sub>	312.2	Nefe78
Rb 3d			K <sub>3</sub> Rh(NO <sub>2</sub> ) <sub>6</sub>	310.5	SNMK78
Rb	111.5	Φ	K <sub>3</sub> Rh(NO <sub>3</sub> ) <sub>6</sub>	311.1	SNMK78
RbCl	109.9	Φ	Rh(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	310.5	Nefe78
RbN <sub>3</sub>	109.8	SGRS72	Rh(NO) <sub>6</sub> Cl <sub>3</sub>	309.8	Nefe78
RbI	110.4	MVS 73	ClRh(Ph <sub>3</sub> P) <sub>3</sub>	307.4	CWH82, Nefe78, OIIT79
RbBr	110.0	MVS 73	Cl <sub>3</sub> Rh(Ph <sub>3</sub> P) <sub>3</sub>	309.7	CWH82
RbCl	109.9	MVS 73	Cl <sub>6</sub> Rh(Ph <sub>3</sub> P) <sub>3</sub>	309.7	Nefe78
RbF	109.8	MVS 73	Br <sub>6</sub> Rh(Ph <sub>3</sub> P) <sub>3</sub>	307.9	Nefe78
Rb <sub>3</sub> PO <sub>4</sub>	110.0	MVS 73	NORh(Ph <sub>3</sub> P) <sub>3</sub>	308.2	Nefe78
Rb <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	110.0	MVS 73	Cl <sub>3</sub> Rh(Ph <sub>3</sub> P) <sub>2</sub> MeCN	309.6	GIWa79
RbClO <sub>4</sub>	110.4	MVS73	H(CO)Rh(Ph <sub>3</sub> P) <sub>2</sub>	308.5	OIIT79
Re 4f			Cl(CO) <sub>2</sub> Rh(Ph <sub>3</sub> P)	308.7	Nefe78
Re	40.3	Φ	Cl(CO)Rh(Ph <sub>3</sub> P) <sub>2</sub>	308.6	CWH82, OIIT79
Re	40.5	FHR80	Cl <sub>2</sub> Rh <sub>2</sub> (cyclooctadien) <sub>2</sub>	308.7	CMHL77, CWH82
Re	40.5	SSHU83, WRDM79	Rh <sub>2</sub> (OAc) <sub>4</sub> · 2H <sub>2</sub> O	309.0	Nefe78
Re	41.0	BHU81	Rh(NH <sub>2</sub> CH <sub>2</sub> COO) <sub>3</sub> · H <sub>2</sub> O	310.3	NPBS74
ReO <sub>2</sub>	43.6	BHU81	Ru 3d		
ReO <sub>3</sub>	46.8	BHU81	Ru	280.1	Φ
K <sub>2</sub> ReCl <sub>6</sub>	44.2	CoHe72, LeBr72	Ru	280.0	NyMa80
Cl <sub>3</sub> ReO(Ph <sub>3</sub> P) <sub>2</sub>	43.9	Folk73, Nefe78	Ru	280.1	Folk73, BHHK70, KiWi74, FEMY77, WRDM79
Cl <sub>2</sub> ReN(Ph <sub>3</sub> P) <sub>2</sub>	42.7	Nefe78	RuCl <sub>3</sub>	281.8	Folk73
Cl <sub>4</sub> Re(Et <sub>3</sub> P <sub>2</sub> )	43.3	LeBr72	RuO <sub>2</sub>	280.7	SaRa80, KiWi74, McGi82
Cl <sub>4</sub> Re(PMe <sub>2</sub> Ph) <sub>2</sub>	43.6	LeBr72	RuO <sub>3</sub>	282.5	KiWi74
Cl <sub>3</sub> Re(PMe <sub>2</sub> Ph) <sub>3</sub> , mer	41.8	LeBr72	RuO <sub>4</sub>	283.3	KiWi74
Cl <sub>2</sub> Re(PMe <sub>2</sub> Ph) <sub>4</sub> , trans	40.5	LeBr72	Ru(NH <sub>3</sub> ) <sub>3</sub> N <sub>2</sub> I <sub>2</sub>	282.2	Folk73
ClReN <sub>2</sub> (PMe <sub>2</sub> Ph) <sub>4</sub> , trans	40.3	LeBr72, Folk73	Ru(NH <sub>3</sub> ) <sub>3</sub> N <sub>2</sub> Br <sub>2</sub>	280.5	Folk73
Rh 3d			Ru(NH <sub>3</sub> ) <sub>3</sub> N <sub>2</sub> Cl <sub>2</sub>	282.5	Folk73
Rh	307.2	Φ	Cl <sub>3</sub> Ru(PhPMe <sub>2</sub> ) <sub>3</sub> mer	276.6	LeBr72
Rh	307.2	NyMa80	S 2p		
Rh	307.2	OIIT79, WRDM79, FHPW73	S	164.0	Φ
RhI <sub>3</sub>	308.6	Nefe78	S	164.1	SNRS76, WRDM79, RiVe83, LHJG70
RhCl <sub>3</sub>	310.1	OIIT79	BaS	160.1	SiW80
RhCl <sub>3</sub> · 3H <sub>2</sub> O	310.0	CWH82	CdS	161.7	BSRR81
RhCl <sub>3</sub> · 12H <sub>2</sub> O	310.1	CMHL77	CoS	162.0	Limo81
Rh <sub>2</sub> O <sub>3</sub>	308.8	NFS82, CMHL77	Cu <sub>2</sub> S	161.3	BSRR81
Rh <sub>2</sub> O <sub>3</sub>	308.2	OIIT79	Cu <sub>2</sub> S	162.4	NSSP80
BaRh <sub>2</sub> O <sub>4</sub>	308.4	NFS82	CuS	162.0	Limo81, NSSP80
BeRh <sub>2</sub> O <sub>4</sub>	308.9	NFS82	CuS	161.3	BSRR81
CaRh <sub>2</sub> O <sub>4</sub>	308.8	NFS82	FeS	161.6	Bind73, Limo81
CoRh <sub>2</sub> O <sub>4</sub>	308.8	NFS82	FeS <sub>2</sub>	162.9	Bind73, Limo81
PbRh <sub>2</sub> O <sub>4</sub>	308.6	NFS82	Ga <sub>2</sub> S <sub>3</sub>	162.2	TIWB72
KRhO <sub>2</sub>	308.5	NFS82	GeS	161.8	SFS77
LiRhO <sub>2</sub>	308.9	NFS82	GeS <sub>2</sub>	161.7	HKMP74
ZnRh <sub>2</sub> O <sub>4</sub>	308.7	NFS82	HgS	162.0	NSSP80
Rh <sub>2</sub> MoO <sub>6</sub>	309.2	NFS82	MnS	162.5	Limo81

MoS <sub>2</sub>	162.5	SSOT81, StEd75, PCLH76	Thiophene	164.3	LHGJ70
Na <sub>2</sub> S	160.6	SWH71	Ph <sub>3</sub> PS	162.4	FIWe75, MSAV71
Na <sub>2</sub> S	161.8	LHGJ70	Ph <sub>3</sub> PS	161.8	HVV79
NiS	162.2	ShRe79, NgHe76, DPS77	Ph <sub>3</sub> AsS	161.7	HVV79
PbS	160.8	SFS77	PhSSPh	164.4	RiVe83, LHGJ70
Sb <sub>2</sub> S <sub>3</sub>	161.8	BCH75	PhCH <sub>2</sub> SSCH <sub>2</sub> Ph	164.2	RiVe83
SnS	161.1	SFS77	(PhS) <sub>3</sub> P	163.6	MSAV71
US	161.5	SNRS76	(PhS) <sub>3</sub> PS	163.5	MSAV71
US <sub>3</sub>	162.6	SNRS76	BuSSBu	164.1	RiVe83
WS <sub>2</sub>	162.1	NgHe76	MeSSMe	164.3	RiVe83
WS <sub>2</sub>	163.0	Wagn75	NH <sub>2</sub> CSNH <sub>2</sub>	162.1	LeRa77, NBMO73, SrWa77
ZnS	164.0	Limo81	2-Mercaptobenzimidaz	162.2	YY79
GeS <sub>2</sub> TeAs <sub>2</sub>	161.5	HKMP74	2-Mercaptobenzimidaz	162.8	ChHa79
GeS <sub>3</sub> As <sub>2</sub>	161.6	HKMP74	BuNH <sub>3</sub> HSO <sub>4</sub>	167.3	EvRe81
KFeS <sub>2</sub>	161.6	Bind73	Bu <sub>4</sub> NHSO <sub>4</sub>	168.0	EvRe81
Na <sub>2</sub> (S <sup>+</sup> SO <sub>3</sub> )	162.5	Wagn75	Et <sub>3</sub> NHHSO <sub>4</sub>	168.5	EvRe81
Na <sub>2</sub> (S <sup>+</sup> SO <sub>3</sub> )	161.7	LHGJ70	PhSCMe <sub>3</sub>	162.4	PiLu72
Na <sub>2</sub> (SS <sup>+</sup> O <sub>3</sub> )	167.7	LHGJ70	Tetrathionaphthalene	164.4	RiVe83
K <sub>2</sub> SO <sub>3</sub>	167.5	TMR80	Cysteine	163.2	LIMa79, LHGJ70
Na <sub>2</sub> SO <sub>3</sub>	165.6	SWH71	Cysteine HCl hydrate	163.1	SSEW79
Na <sub>2</sub> SO <sub>3</sub>	166.6	WaTa82, LHGJ70	Cysteine HCl hydrate	163.6	LHGJ70
Na <sub>2</sub> SO <sub>3</sub>	167.2	TMR80	Methionine	162.8	BBFR77
Ag <sub>2</sub> SO <sub>4</sub>	168.6	TMR80	NH <sub>2</sub> C <sub>6</sub> H <sub>4</sub> SO <sub>3</sub> H	167.8	HaSh73
Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	168.8	LHGJ70	(MeOS) <sub>2</sub>	164.5	LHGJ70
BaSO <sub>4</sub>	168.8	SiWo80, CLSW83	Me <sub>2</sub> SO	166.5	LHGJ70
CaSO <sub>4</sub>	169.0	CLSW83	(PhCH <sub>2</sub> ) <sub>2</sub> SO	165.9	LHGJ70
CoSO <sub>4</sub>	169.7	Limo81	Ph <sub>2</sub> SO	166.0	LHGJ70
CuSO <sub>4</sub>	169.3	WaTa80, NSSP80, Limo81	Me <sub>2</sub> SO <sub>2</sub>	169.0	LHGJ70
FeSO <sub>4</sub>	168.8	Limo81, LHGJ70	CH <sub>3</sub> OS(O)OCH <sub>3</sub>	168.4	LHGJ70
Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	169.1	LHGJ70	MeSO <sub>2</sub> Cl	169.3	LHGJ70
K <sub>2</sub> SO <sub>4</sub>	169.1	TMR80	ClC <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> SO <sub>2</sub> Cl	168.5	LHGJ70
MnSO <sub>4</sub>	171.0	Limo81	PhSO <sub>2</sub> Na	166.3	LHGJ70
Na <sub>2</sub> SO <sub>4</sub>	168.8	TMR80	p-NH <sub>2</sub> C <sub>6</sub> H <sub>4</sub> SO <sub>2</sub> C <sub>6</sub> H <sub>4</sub> NH <sub>2</sub>	167.9	LHGJ70
NiSO <sub>4</sub>	169.2	Limo81, NSLS77, Nefe82, ShRe79	p-NH <sub>2</sub> C <sub>6</sub> H <sub>4</sub> SO <sub>2</sub> NH <sub>2</sub>	168.4	LHGJ70
PbSO <sub>4</sub>	168.6	NSSP80	p-CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub> SO <sub>2</sub> Cl	168.4	LHGJ70
SrSO <sub>4</sub>	169.1	CLSW83	p-NH <sub>2</sub> C <sub>6</sub> H <sub>4</sub> SO <sub>3</sub> Na	168.1	LHGJ70
U(SO <sub>4</sub> ) <sub>2</sub>	169.1	Chad73	p-O <sub>2</sub> NC <sub>6</sub> H <sub>4</sub> SNa	161.0	LHGJ70
ZnSO <sub>4</sub>	169.5	Nefe82	CO <sub>2</sub> NC <sub>6</sub> H <sub>4</sub> SH	163.5	LHGJ70
NO <sub>3</sub> SO <sub>3</sub>	166.8	BCM78	p-O <sub>2</sub> NC <sub>6</sub> H <sub>4</sub> SH	163.9	LHGJ70
S <sub>2</sub> N <sub>2</sub>	164.6	SDIO77	p-O <sub>2</sub> NC <sub>6</sub> H <sub>4</sub> SM <sub>2</sub>	163.5	LHGJ70
SF <sub>6</sub>	174.4	WaTa82	p-O <sub>2</sub> NC <sub>6</sub> H <sub>4</sub> SNH <sub>2</sub>	164.1	LHGJ70
SF <sub>6</sub>	177.2	LHGJ70	p-O <sub>2</sub> NC <sub>6</sub> H <sub>4</sub> SCI	163.9	LHGJ70
SO <sub>2</sub>	167.4	WaTa82	p-O <sub>2</sub> NC <sub>6</sub> H <sub>4</sub> SO <sub>2</sub> F	169.6	LHGJ70
SO <sub>2</sub>	168.1	LHGJ70	p-O <sub>2</sub> NC <sub>6</sub> H <sub>4</sub> SO <sub>2</sub> F	170.0	LHGJ70
SOCl <sub>2</sub>	168.1	LHGJ70	PhCH <sub>2</sub> SSCH <sub>2</sub> Ph	163.6	LHGJ70
SOF <sub>2</sub>	170.0	LHGJ70	PhCH <sub>2</sub> S*SOCH <sub>2</sub> Ph	163.7	LHGJ70
SP(NH <sub>3</sub> ) <sub>3</sub>	162.3	FIWe75	PhCH <sub>2</sub> SS*OCH <sub>2</sub> Ph	165.9	LHGJ70
SPCl <sub>3</sub>	163.7	FIWe75	PhCH <sub>2</sub> S*SO <sub>2</sub> CH <sub>2</sub> Ph	163.9	LHGJ70
S <sub>2</sub> Cl <sub>2</sub>	163.5	LHGJ70	PhCH <sub>2</sub> SS*O <sub>2</sub> CH <sub>2</sub> Ph	168.0	LHGJ70
S <sub>2</sub> Cl <sub>10</sub>	174.4	LHGJ70	(CH <sub>3</sub> ) <sub>3</sub> S+I-	165.8	LHGJ70
CS <sub>2</sub>	163.7	LHGJ70	(CH <sub>3</sub> ) <sub>3</sub> S+(O)I-	168.2	LHGJ70
(CH <sub>2</sub> COOH) <sub>2</sub> S	163.7	LHGJ70	(HOOCCH <sub>2</sub> ) <sub>2</sub> S+CH <sub>2</sub> COO-	166.2	LHGJ70
(CH <sub>2</sub> Ph) <sub>2</sub> S	163.3	LHGJ70			
PhSH	163.1	LHGJ70	S KLL		
Ph <sub>2</sub> S	163.2	LHGJ70	NiS	2116.1	WaTa80
			NiW <sub>2</sub> S	2115.9	Wagn78

WS <sub>2</sub>	2115.6	Wagn78	Sc 2p	398.6	Φ
Na <sub>2</sub> SO <sub>3</sub>	2108.5	WaTa82	Sc	398.6	Φ
Na <sub>2</sub> (SS <sup>+</sup> O <sub>3</sub> )	2107.8	Wagn75	Sc <sub>2</sub> O <sub>3</sub>	401.8	Φ
Na <sub>2</sub> (S <sup>+</sup> SO <sub>3</sub> )	2112.5	Wagn75	Sc	398.7	SMKM77
CuSO <sub>4</sub>	2108.0	WaTa80	ScN	400.7	STAB76
SO <sub>2</sub>	2106.2	WaTa82	Sc <sub>2</sub> O <sub>3</sub>	401.9	NGDS75, WRDM79
SF <sub>6</sub>	2100.5	WaTa82	ClSc(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	401.4	WeMe78
			Sc(C <sub>5</sub> H <sub>5</sub> )(C <sub>8</sub> H <sub>8</sub> )	400.2	WeMe78
<b>Sb 3d<sub>5/2</sub></b>					
Sb	528.3	Φ	<b>Se 3d</b>		
Sb	528.2	HSBS81, MSV 73, PVVA79, SFS77, WRDM79, Wagn75	Se	55.6	Φ
AlSb	528.6	MSV73	Se	55.5	SFS77, BWI80, UeOd82, WRDM79, WSP77, MTHB71
Sb <sub>2</sub> Sn <sub>5</sub>	528.0	HSBS81	Se	55.1	BWI80
Sb <sub>2</sub> S <sub>3</sub>	529.5	MSV73, Wagn75	As <sub>2</sub> Se <sub>3</sub>	55.1	UeOd82, WSP77
Sb <sub>2</sub> S <sub>5</sub>	529.2	MSV73, Wagn75	Ga <sub>2</sub> Se <sub>3</sub>	54.6	ITI82, TIWB72
SbI <sub>3</sub>	530.4	MSV73	GeSe	54.8	SFS77
SbCl <sub>5</sub>	530.9	BCH75	GeSe <sub>2</sub>	54.5	UeOd82
SbF <sub>5</sub>	531.7	MSV73	CuInSe <sub>2</sub>	54.0	KJID81
Sb <sub>2</sub> O <sub>3</sub>	530.0	MSV73, Wagn75	In <sub>2</sub> Se <sub>3</sub>	54.8	KJID81
Sb <sub>2</sub> O <sub>5</sub>	530.8	MSV73	Nb <sub>3</sub> Se <sub>4</sub>	54.9	Bahl75
Rb <sub>3</sub> Sb <sub>2</sub> Br <sub>9</sub>	529.9	Tric74	NbSe <sub>2</sub>	53.7	Bahl75
Rb <sub>3</sub> Sb <sub>2</sub> I <sub>9</sub>	529.9	Tric74	PbSe	53.4	SFS77
Cs <sub>3</sub> Sb <sub>2</sub> I <sub>9</sub>	529.2	BCH75	PbSe	54.1	WSP77
Cs <sub>3</sub> Sb <sub>2</sub> Br <sub>9</sub>	530.0	BCH75, Tric74	SnSe	53.7	SFS77
Cs <sub>3</sub> Sb <sub>2</sub> Cl <sub>9</sub>	529.3	BCH75	SnSe	55.0	WSP77
Cs <sub>3</sub> Sb <sub>2</sub> Cl <sub>9</sub>	530.5	Tric74	MoSe <sub>2</sub>	54.6	BWI79
Cs <sub>3</sub> SbCl <sub>6</sub>	530.9	Tric74	FeSe <sub>2</sub>	54.9	BWI79
Co(NH <sub>3</sub> ) <sub>6</sub> SbBr <sub>6</sub>	530.1	Tric74	SeO <sub>2</sub>	58.9	BWI81, ITI82
Co(NH <sub>3</sub> ) <sub>6</sub> SbCl <sub>6</sub>	530.8	Tric74	SeO <sub>2</sub>	59.8	MTHB71, WSP77
KSbF <sub>6</sub>	532.3	MSV73	H <sub>2</sub> SeO <sub>3</sub>	59.2	BWI81
KSbF <sub>6</sub>	532.9	Wagn75	H <sub>2</sub> SeO <sub>3</sub>	59.9	MTHB71
Na <sub>3</sub> SbF <sub>6</sub>	532.1	BCH75	H <sub>2</sub> SeO <sub>4</sub>	61.2	BWI81
Cs <sub>3</sub> SbF <sub>6</sub>	530.6	BCH75	Na <sub>2</sub> SeO <sub>3</sub>	59.1	WSP77
KSb <sub>2</sub> F <sub>7</sub>	531.2	Tric74	Na <sub>2</sub> SeO <sub>4</sub>	61.6	WSP77
K <sub>2</sub> SbF <sub>5</sub>	531.0	Tric74	Na <sub>2</sub> SeS <sub>4</sub> O <sub>6</sub>	56.9	WSP77
Na <sub>2</sub> SbF <sub>5</sub>	531.3	Tric74	Ph <sub>2</sub> Se	55.8	BWI81
BuNH <sub>3</sub> SbI <sub>4</sub>	529.6	BCH75	(BrC <sub>6</sub> H <sub>4</sub> ) <sub>2</sub> Se	56.4	MTHB71
BuNH <sub>3</sub> Sb <sub>2</sub> I <sub>9</sub>	529.9	BCH75	Ph <sub>2</sub> Se <sub>2</sub>	55.8	BWI81
Et <sub>4</sub> NSbF <sub>6</sub>	532.4	BCH75	(BrC <sub>6</sub> H <sub>4</sub> ) <sub>2</sub> Se <sub>2</sub>	56.0	BWI81
Ph <sub>3</sub> Sb	528.9	BCH75	(C <sub>14</sub> H <sub>29</sub> Se) <sub>2</sub>	56.1	MTHB71
Bu <sub>3</sub> Sb	528.1	BCH75	I <sub>2</sub> SePh <sub>2</sub>	58.1	BWI81
Ph <sub>3</sub> SbBr <sub>2</sub>	529.8	BCH75	Br <sub>2</sub> SePh <sub>2</sub>	57.8	BWI81
Me <sub>3</sub> SbBr <sub>2</sub>	530.3	BCH75	Cl <sub>2</sub> SePh <sub>2</sub>	57.7	BWI81
Ph <sub>3</sub> SbS	528.7	BCH75	Cl <sub>2</sub> SePh <sub>2</sub>	58.8	MTHB71
(C <sub>12</sub> H <sub>25</sub> ) <sub>3</sub> SSb	529.8	MSV73	C <sub>16</sub> H <sub>33</sub> SeCN	57.7	MTHB71
Ph <sub>4</sub> PSbCl <sub>6</sub>	531.7	MSV73	HSePh <sub>2</sub> P	54.5	NSWM80
			SePh <sub>2</sub> P	54.3	HVV79
<b>Sb MNN</b>			Ph <sub>2</sub> SeO	57.6	BWI81
Sb	464.1	WRDM79, PVVA79, Wagn75	(PhCH <sub>2</sub> ) <sub>2</sub> SeO	58.2	MTHB71
Sb <sub>2</sub> S <sub>3</sub>	462.1	Wagn75	(BrC <sub>6</sub> H <sub>4</sub> ) <sub>2</sub> SeO	58.4	MTHB71
Sb <sub>2</sub> S <sub>5</sub>	462.2	Wagn75	(C <sub>4</sub> H <sub>8</sub> COOH) <sub>2</sub> SeO	58.5	MTHB71
Sb <sub>2</sub> O <sub>3</sub>	462.1	Wagn75	PhSeO(OH)	58.8	MTHB71
KSbF <sub>6</sub>	454.4	Wagn75	ClC <sub>6</sub> H <sub>4</sub> SeO(OH)	59.3	MTHB71

FC <sub>6</sub> H <sub>4</sub> SeO(OH)	59.3	MTHB71	Hydroxysodalite	101.7	WPHK82
ClC <sub>6</sub> H <sub>4</sub> SeO <sub>2</sub> (OH)	60.2	MTHB71	Kaolinite	102.7	Barr83
(MeOC <sub>6</sub> H <sub>4</sub> ) <sub>2</sub> SeO <sub>2</sub>	60.0	MTHB71	Kaolinite	103.0	WPHK82
(HOC <sub>2</sub> H <sub>4</sub> S) <sub>2</sub> Se	56.2	WSP77	Mica, Muscovite	102.4	WPHK82
<b>Se LMM</b>			Natrolite	102.2	WPHK82
Se	1307.0	BWI81	Pyrophyllite	102.9	WPHK82
Se	1306.7	Wagn75	AlSiO <sub>5</sub> , sillimanite	102.7	WPHK82
SeO <sub>2</sub>	1301.4	BWI81	LiAlSi <sub>2</sub> O <sub>6</sub> , spodumene	102.5	WPHK82
H <sub>2</sub> SeO <sub>3</sub>	1300.8	BWI81	Talc, Mg <sub>2</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	103.1	WPHK82
H <sub>2</sub> SeO <sub>4</sub>	1297.9	BWI81	Wollastonite, Ca <sub>3</sub> Si <sub>3</sub> O <sub>9</sub>	102.4	WPHK82
Na <sub>2</sub> SeO <sub>3</sub>	1301.2	Wagn75	Mol Sieve A	101.4	WPHK82
Ph <sub>2</sub> Se	1304.0	BWI81	Mol Sieve A, Ca form	101.3	Barr83
Ph <sub>2</sub> Se <sub>2</sub>	1304.3	BWI81	Mol Sieve X	102.2	WPHK82
I <sub>2</sub> SePh	1302.1	BWI81	Mol Sieve X	102.2	Barr83
Cl <sub>2</sub> SePh <sub>2</sub>	1302.9	BWI81	Mol Sieve X, Ca form	102.7	Barr83
Ph <sub>2</sub> SeO	1301.9	BWI81	Mol Sieve Y	102.8	WPHK82
<b>Si 2p</b>			Mol Sieve Y	102.8	Barr83
Si	99.3	Φ	Mol Sieve Y, Ca form	102.8	Barr83
SiO <sub>2</sub>	103.3	Φ	K <sub>2</sub> SiF <sub>6</sub>	104.6	MoVa73
Si	99.5	AWL80, PADS78, WRDM79, WPHK82, Tayl81, KBHN74	Na <sub>2</sub> SiF <sub>6</sub>	104.3	NSLS77
Si, p-type	99.0	HBBK72	p-Methylsil. (linear)	102.4	WPHK82
Si, n-type	100.0	HBBK72	p-Methylsil. (resin)	102.9	WPHK82
Si, (100)	99.7	TLR78	p-Phenylsil. (resin)	102.7	WPHK82
Fe <sub>3</sub> Si	99.5	ShTr75	Me <sub>4</sub> Si	100.5	GCH76
MoSi <sub>2</sub>	99.6	WPHK82	Ph <sub>4</sub> Si	100.7	MoVa73
MoSi <sub>2</sub>	99.1	BrWh78	Ph <sub>4</sub> Si	101.2	GCH76
Ni <sub>2</sub> Si	98.9	GGM82	Et <sub>3</sub> SiH	100.7	GCH76
NiSi	98.8	GGM82	Et <sub>3</sub> SiOH	101.1	GCH76
NiSi	98.4	AWL80	Et <sub>3</sub> SiBr	101.0	GCH76
Pd <sub>2</sub> Si	99.7	GGM82	Et <sub>3</sub> SiCl	101.4	GCH76
Pd <sub>3</sub> Si	99.6	AWL80	Et <sub>2</sub> SiCl <sub>2</sub>	102.1	GCH76
PdSi	99.8	WaTa80	Et <sub>3</sub> SiCl <sub>3</sub>	102.9	GCH76
Pt <sub>2</sub> Si	100.5	GGM82	(CH <sub>2</sub> =CH) <sub>4</sub> Si	100.7	GCH76
PtSi	100.5	GGM82	Me <sub>3</sub> SiSiMe <sub>3</sub>	100.5	GCH76
Si <sub>3</sub> N <sub>4</sub>	101.8	WHMC78, WaTa80, Tayl81, TLR78	Me <sub>3</sub> SiOSiMe <sub>3</sub>	100.9	GCH76
SiS <sub>2</sub>	103.4	MoVa73	Ph <sub>3</sub> SiSiPh <sub>3</sub>	100.7	GCH76
SiO <sub>2</sub>	103.6	KBHN74, NGDS75, MoVa73, Barr83	Ph <sub>3</sub> SiOSiPh <sub>3</sub>	101.3	GCH76
SiO <sub>2</sub> , Vycor	103.5	WPHK82	<b>Si (KLL)</b>		
SiO <sub>2</sub> , quartz	103.7	WPHK82, TLR 78	Si	1616.6	WPHK82, CDN 77
SiO <sub>2</sub> , alpha cristobal	103.3	WPHK82	MoSi <sub>2</sub>	1617.2	WPHK82
SiO <sub>2</sub> gel	103.4	WPHK82	PdSi	1617.4	WaTa80
Ni <sub>2</sub> SiO <sub>4</sub>	102.9	LFWS79	Si <sub>3</sub> N <sub>4</sub>	1612.6	WaTa80
NiSiO <sub>3</sub>	103.3	SRD79	SiO <sub>2</sub>	1608.8	KBHN74
Al <sub>2</sub> SiO <sub>5</sub> , kyanite	102.8	AnSw74	SiO <sub>2</sub> , Vycor	1608.5	WPHK82
Al <sub>2</sub> SiO <sub>5</sub> , mullite	103.0	AnSw74	SiO <sub>2</sub> , quartz	1608.6	WPHK82
Al <sub>2</sub> SiO <sub>5</sub> , sillimanite	102.6	AnSw74	SiO <sub>2</sub> , alpha cristobal	1608.8	WPHK82
NaAlSi <sub>3</sub> O <sub>8</sub> , albite	102.6	WPHK82	SiO <sub>2</sub> gel	1608.3	WPHK82
Bentonite	102.9	Barr83	NaAlSi <sub>3</sub> O <sub>8</sub> , albite	1609.3	WPHK82
H Zeolon	103.3	WPHK82	H Zeolon	1608.4	WPHK82
Zn <sub>4</sub> Si <sub>2</sub> O <sub>7</sub> (OH) <sub>2</sub> · 2H <sub>2</sub> O	102.0	WPHK82	Hemimorphite	1610.5	WPHK82
			Hydroxysodalite	1610.7	WPHK82
			Kaolinite	1609.0	WPHK82
			Mica, Muscovite	1609.6	WPHK82

Natrolite	1609.6	WPHK82	Ph <sub>4</sub> Sn	487.1	HWWV74
Pyrophyllite	1609.2	WPHK82	Ph <sub>3</sub> SnI	486.3	WVV79
Al <sub>2</sub> SiO <sub>5</sub> , sillimanite	1609.5	WPHK82	Ph <sub>3</sub> SnI	487.5	HWWV74
LiAlSi <sub>2</sub> O <sub>6</sub> , spodumene	1609.6	WPHK82	Ph <sub>3</sub> SnBr	487.5	HWWV74
Talc, Mg <sub>3</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	1608.9	WPHK82	Ph <sub>3</sub> SnCl	486.3	WVV79
Wollastonite, Ca <sub>3</sub> Si <sub>3</sub> O <sub>9</sub>	1610.0	WPHK82	Ph <sub>3</sub> SnCl	487.0	MoVa73
Mol Sieve A	1610.1	WPHK82	Ph <sub>3</sub> SnCl	487.6	HWWV74
Mol Sieve X	1609.4	WPHK82	Ph <sub>3</sub> SnF	486.2	WVV79
Mol Sieve Y	1608.6	WPHK82	Ph <sub>3</sub> SnF	487.3	HWWV74
p-Methylsil. (linear)	1609.4	WPHK82	Ph <sub>3</sub> SnOH	485.6	WVV79
p-Methylsil. (resin)	1608.8	WPHK82	Cl <sub>4</sub> Sn(pyridine) <sub>2</sub>	487.3	WVV79
p-Phenylsil. (resin)	1610.0	WPHK82	Cl <sub>3</sub> SnEt(pyridine) <sub>2</sub>	487.2	WVV79
Cl <sub>3</sub> SnPh(pyridine) <sub>2</sub>			Cl <sub>3</sub> SnPh(pyridine) <sub>2</sub>	487.2	WVV79
Me <sub>3</sub> SnF			Me <sub>3</sub> SnF	486.7	WVV79
Sm 3d <sub>5/2</sub>			Me <sub>2</sub> SnF <sub>2</sub>	487.1	WVV79
Sm	1081.1	Φ	Me <sub>2</sub> SnO <sub>4</sub>	487.0	WVV79
Sm	1081.2	DKMB76	Bu <sub>2</sub> SnO	485.6	WVV79
Sm <sub>2</sub> O <sub>3</sub>	1083.4	WRDM79	Br <sub>6</sub> Sn(Et <sub>4</sub> N) <sub>2</sub>	487.0	WVV79
Sn 3d <sub>5/2</sub>			Cl <sub>3</sub> Sn(Me <sub>4</sub> N)	486.1	GZF73
Sn	485.0	Φ	Cl <sub>4</sub> Sn(Me <sub>2</sub> SO) <sub>2</sub>	487.0	GZF73, WVV79
Sn	484.9	NyMa80			
Sn	485.1	SFS77	Sn MNN		
Sn	485.0	WRDM79, PVVA79, LAK 77, Wagn75, OCH 79	Sn	437.4	PVVA79, Wagn75, WRDM79, LAK 77
Sn alpha	485.0	Hegd82	SnS	435.7	Wagn75
Sn beta	484.6	Hegd82, HSBS81	SnO <sub>2</sub>	432.7	LAK77
Ag <sub>95</sub> Sn <sub>5</sub>	485.6	HSBS81, Hegd82	NaSnF <sub>3</sub>	430.8	Wagn75
AuSn	485.2	FHPW73	Na <sub>2</sub> SnO <sub>3</sub>	431.7	Wagn75
AuSn <sub>4</sub>	484.9	FHPW73			
Cd <sub>99</sub> · 5Sn · OO <sub>5</sub>	485.3	Hegd82	Sr 3d		
Cd <sub>95</sub> Sn <sub>5</sub>	485.6	Hegd82	Sr	134.3	Φ
In <sub>95</sub> Sn <sub>5</sub>	485.2	Hegd82	Sr	134.4	VaVe80
Pb <sub>95</sub> Sn <sub>5</sub>	486.4	Hegd82	SrO	135.3	VaVe80
Sb <sub>95</sub> Sn <sub>5</sub>	485.2	Hegd82	SrF <sub>2</sub>	133.8	WRDM79
SnTe	485.6	SFS77	SrCO <sub>3</sub>	133.2	CLSW83
SnSe	485.7	SFS77	SrSO <sub>4</sub>	134.3	CLSW83
SnS	485.6	SFS77	Sr(NO <sub>3</sub> ) <sub>2</sub>	134.7	CLSW83
SnBr <sub>2</sub>	486.9	GZF73	SrMoO <sub>4</sub>	133.5	NFS82
SnCl <sub>2</sub>	486.7	WVV79	SrRh <sub>2</sub> O <sub>4</sub>	133.0	NFS82
SnF <sub>2</sub>	487.0	MoVa73			
SnF <sub>2</sub>	487.0	MoVa73	Ta 4f		
SnO	486.0	ADPS77	Ta	21.9	Φ
SnO	486.9	WVV79, MoVa73	Ta	21.6	VHE82
SnO <sub>2</sub>	486.7	LAK 77, MoVa73, WRDM79, NGDS75, WVV79	Ta	21.6	MSC73
(NH <sub>4</sub> ) <sub>2</sub> SnCl <sub>6</sub>	486.7	GZF73	Ta	21.9	WRDM79, WaTa80
BaSnCl <sub>4</sub>	486.8	WVV79	TaS	26.6	MSC73
Ba(SnCl <sub>3</sub> ) <sub>2</sub>	486.8	WVV79	TaS <sub>2</sub>	26.7	MSC73
KSnF <sub>3</sub>	486.7	GZF73	TaBr <sub>5</sub>	26.9	MSC73
K <sub>2</sub> SnF <sub>6</sub>	487.6	MoVa73	TaCl <sub>5</sub>	27.3	MSC73
NaSnF <sub>3</sub>	487.4	Wagn75	TaF <sub>5</sub>	27.8	MSC73
Na <sub>2</sub> SnO <sub>3</sub>	486.2	MoVa73	Ta <sub>2</sub> O <sub>5</sub>	26.7	SaRa80, MSC 73, NFS82, NGDS75
Na <sub>2</sub> SnO <sub>3</sub>	486.7	Wagn75	KTaO <sub>4</sub>	25.9	MSC73
Na <sub>2</sub> SnO <sub>3</sub>	487.2	ADPS77	RhTaO <sub>4</sub>	25.8	NFS82
Ph <sub>4</sub> Sn	485.1	WVV79	K <sub>2</sub> TaF <sub>7</sub>	29.4	MSC73
Ph <sub>4</sub> Sn	486.3	MoVa73			

$\text{Cl}_2\text{Ta}_6\text{Cl}_{12}(\text{H}_2\text{O})_4 \cdot 4\text{H}_2\text{O}$	25.8	BeWa79	Te MNN	Te	492.2	WRDM79
$\text{Br}_6(\text{Ta}_6\text{Cl}_{12})(\text{Bu}_4\text{N})_2$	26.3	BeWa79		$\text{TeBr}_2$	487.3	BWI78
$\text{Cl}_6(\text{Ta}_6\text{Cl}_{12})(\text{Et}_4\text{N})_2$	26.2	BeWa79		$\text{TeCl}_4$	486.1	BWI78
Ta MNN				$\text{TeO}_2$	487.1	BWI78
Ta	1674.8	WaTa80		$\text{TeO}_3$	485.5	BWI78
Tb 4d				$\text{Te(OH)}_6$	485.1	BWI78
Tb	146.0	Φ		$(\text{NH}_4)_2\text{TeCl}_6$	486.4	BWI78
$\text{Tb}_2\text{O}_3$	148.7	SaRa80		$\text{Na}_2\text{TeO}_4$	485.5	Wagn75
$\text{TbO}_2$	149.2	SaRa80		$\text{Cl}_2\text{TePh}_2$	486.3	BWI78
Tb 3d				$\text{Br}_2\text{TePh}_2$	486.6	BWI78
Tb	1242.0	Φ		$\text{I}_2\text{TePh}_2$	487.8	BWI78
$\text{Tb}_2\text{O}_3$	1241.5	SaRa80		$\text{I}_2\text{TeEt}_2$	487.6	BWI78
$\text{TbO}_2$	1241.4	SaRa80		$\text{Ph}_2\text{Te}_2$	488.5	BWI78
Te 3d <sub>5/2</sub>				$\text{Br}_3\text{TePh}$	486.8	BWI78
Te	573.1	Φ		$\text{I}_3\text{TePh}$	488.2	BWI78
Te	573.0	NyMa80		$\text{I}_2\text{TeMe}_2$	486.6	BWI78
Te	573.0	SFS77	Th 4f <sub>7/2</sub>	p-tolyl TeOOH	486.6	BWI78
Te	573.0	PVVA79, WRDM79, BWI77, Bahl75		$\text{Br}_3\text{TeBu}$	486.5	BWI78
Te	572.7	SNRS76, SWH71	Th		333.2	Φ
CdTe	572.3	SBB80	Th		333.2	WRDM79
GeTe	572.7	SFS77	ThO <sub>2</sub>		334.4	VLDH77
$\text{Hg}_{0.8}\text{Cd}_{0.2}\text{Te}$	572.3	SBB80	ThF <sub>4</sub>		336.5	WRDM79
$\text{Na}_2\text{Te}$	572.2	SWH71	Th 4d <sub>5/2</sub>			
$\text{Nb}_3\text{Te}_4$	572.6	Bahl75	Th		675.3	FBWF74
$\text{NbTe}_4$	572.8	Bahl75	ThO <sub>2</sub>		675.5	VLDH77
PbTe	572.0	SFS77	Ti 2p			
SnTe	572.3	SFS77	Ti		454.1	Φ
$\text{U}_2\text{Te}_3$	572.9	SNRS76	$\text{TiO}_2$		458.8	Φ
$\text{UTe}_3$	573.0	SNRS76	Ti		453.7	ALMP82
ZnTe	572.9	SWH71	Ti		453.9	LANM81
$\text{TeI}_4$	575.8	BWI77	Ti		453.9	NSCP74, WRDM79
$\text{TeBr}_2$	576.7	BWI77	$\text{TiB}_2$		454.4	MECC73
$\text{TeCl}_4$	576.9	BWI77	TiN		455.8	STAB76
$\text{TeO}_2$	575.7	GBP81, SBB80	$\text{TiCl}_4$		458.5	MRV83
$\text{TeO}_3$	576.6	SWH71	TiO		455.1	SPB76a
$\text{Te(OH)}_6$	577.1	BWI77	$\text{TiO}_2$		458.7	NSCP74, SPB76a, WRDM79, NGDS75
$(\text{NH}_4)_2\text{TeCl}_6$	576.9	BWI77	$\text{TiO}_2$ (anatase, rutile)		459.2	MWI75
$(\text{NH}_4)_2\text{TeO}_4$	576.5	SWH71	$\text{BaTiO}_3$ (cubic, tetra.)		458.5	MWI75
$\text{K}_2\text{TeO}_3$	575.5	SWH71	$\text{CaTiO}_3$		458.9	MWI75
$\text{Na}_2\text{TeO}_4$	576.8	Wagn75	$\text{PbTiO}_3$		458.6	MWI75
$\text{Cl}_2\text{TePh}_2$	576.2	BWI77	$\text{SrTiO}_3$		458.8	MWI75
$\text{Br}_2\text{TePh}_2$	576.2	BWI77	$\text{Cl}_2\text{Ti}(\text{C}_5\text{H}_5)_2$		457.1	GSMJ74
$\text{I}_2\text{TePh}_2$	575.4	BWI77	$\text{ClTi}(\text{C}_5\text{H}_5)_2$		455.8	GSMJ74
$\text{I}_2\text{TeEt}_2$	575.3	BWI77	$\text{Ti}(\text{C}_5\text{H}_5)(\text{C}_7\text{H}_7)$		455.4	GSMJ74
$\text{Ph}_2\text{Te}_2$	573.9	BWI77				
$\text{Br}_3\text{TePh}$	576.6	BWI77	Ti LMM			
$\text{I}_3\text{TePh}$	575.8	BWI77	Ti		419.1	WRDM79
$\text{I}_2\text{TeMe}_2$	575.6	BWI77				
p-tolyl TeOOH	576.1	BWI77				
$\text{Br}_3\text{TeBu}$	576.6	BWI77				

## Tl 4f

Tl	117.7	Φ	V 2p	512.2	Φ
Tl	117.8	MBN80, WRDM79	V <sub>2</sub> O <sub>5</sub>	517.4	Φ
TlI	118.5	MSC73	V	512.1	LANM81
TIBr	119.2	MSC73	V	512.3	WRDM79, NSCP74
TICl	119.0	MSC73	V	512.9	KKL83
TIF	119.2	MSC73	V	513.4	SMKM77
Tl <sub>2</sub> S	118.7	MSC73	V	512.4	RoRo76, LFS 73, FrSa75
Tl <sub>2</sub> S <sub>3</sub>	118.7	MSC73	VB <sub>2</sub>	513.2	MECC73
Tl <sub>2</sub> O <sub>3</sub>	117.5	MSC73	VN	514.4	RoRo76, STAB76
Cl <sub>3</sub> Tl(pyridine) <sub>2</sub>	118.5	Walt77	V <sub>2</sub> O <sub>3</sub>	515.7	CGR78
Cl <sub>6</sub> Tl <sub>2</sub> (PhPEt <sub>2</sub> ) <sub>3</sub>	117.9	Walt77	VO <sub>2</sub>	516.3	KKL83
			V <sub>2</sub> O <sub>5</sub>	517.6	NSLS77, NSCP74, WRDM79, NGDS75, NFS82

## Tm 4d

Tm	175.4	Φ	VOCl <sub>2</sub>	516.4	LFS73
			VOSO <sub>4</sub>	515.9	LFS73
			Cs <sub>3</sub> VO <sub>4</sub>	516.9	NFS82

U 4f<sub>7/2</sub>

U	377.3	Φ	Rb <sub>3</sub> VO <sub>4</sub>	516.9	NFS82
U	377.2	VRPC74, Chad73, WRDM79	Na <sub>3</sub> VO <sub>4</sub>	517.3	NFS82
U <sub>2</sub> Te <sub>3</sub>	380.5	SNRS76	Li <sub>3</sub> VO <sub>4</sub>	517.5	NFS82
UTe <sub>3</sub>	381.3	SNRS76	Rh <sub>3</sub> VO <sub>4</sub>	516.9	NFS82
USe	380.3	SNRS76	K <sub>4</sub> V(CN) <sub>6</sub>	513.3	Vann76
USe <sub>3</sub>	379.1	SNRS76	V(acac) <sub>3</sub>	514.2	LFS73
US	380.1	SNRS76	VO(acac) <sub>2</sub>	515.1	LFS73
US <sub>3</sub>	379.4	SNRS76	ClV(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	513.8	GSMJ74
UBr <sub>3</sub>	378.4	TBVL82	V(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	512.9	GSMJ74, BCDH73
UBr <sub>4</sub>	379.9	TBVL82	V(C <sub>5</sub> H <sub>5</sub> )(C <sub>7</sub> H <sub>7</sub> )	513.3	GSMJ74
UCl <sub>3</sub>	378.3	TBVL82			
UCl <sub>4</sub>	380.2	TBVL82			
UCl <sub>5</sub>	381.9	TBVL82	V LMM	472.0	WRDM79
UF <sub>3</sub>	380.1	TBVL82	V	468.6	KKL83
UF <sub>4</sub>	382.2	TBVL82	VO <sub>2</sub>	468.0	KKL83
UF <sub>4</sub>	382.7	Chad73	V <sub>2</sub> O <sub>5</sub>		
UF <sub>5</sub>	382.6	TBVL82	W 4f		

UO <sub>2</sub>	380.0	VRPC74, Chad73, MSSS81	W	31.4	Φ
U <sub>3</sub> O <sub>8</sub>	381.0	Chad73, ChGr72	W	31.4	VHE82
U <sub>4</sub> O <sub>9</sub>	379.9	HoTh79	W	31.4	WRDM79, CoRa76, CGR 78, BiPo73, NSLS77
UO <sub>3</sub>	381.7	MSSS81, Chad73, ChGr72	WC	31.5	CoRa76
UOBr	380.1	TBVL82	WC	32.2	MSC73
UOBr <sub>2</sub>	380.4	TBVL82	WS <sub>2</sub>	33.2	Wagn75
UOCl	380.0	TBVL82	WBr <sub>5</sub>	36.3	MSC73
UOCl <sub>2</sub>	380.3	TBVL82	WBr <sub>6</sub>	35.9	MSC73
UO <sub>2</sub> Br	380.5	TBVL82	WCl <sub>6</sub>	36.9	MSC73
UO <sub>2</sub> Br <sub>2</sub>	381.1	TBVL82	WOCl <sub>4</sub>	37.2	MSC73
UO <sub>2</sub> Cl <sub>2</sub>	381.6	TBVL82	WO <sub>2</sub>	32.8	CGR78, CoRa76, NgHe76
UO <sub>2</sub> F <sub>2</sub>	382.9	TBVL82, Chad73	W <sub>18</sub> O <sub>49</sub>	34.3	BiPo73
U(SO <sub>4</sub> ) <sub>2</sub>	381.6	Chad73	WO <sub>3</sub>	35.8	SaRa80, CoRa76, CGR 78, BiPo73, KMH 78
UO <sub>3</sub> (NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	382.0	Chad73	WO <sub>3</sub>	35.8	NFS82, NGDS75
U(acac) <sub>4</sub>	379.7	Chad73	Al <sub>2</sub> (WO <sub>4</sub> ) <sub>3</sub>	36.1	BiPo73
UO <sub>2</sub> (AcO) <sub>2</sub> · 2H <sub>2</sub> O	381.0	Chad73	CaWO <sub>4</sub>	35.0	Nef82, NFS 82
CaUO <sub>4</sub>	380.7	Chad73	H <sub>2</sub> WO <sub>4</sub>	35.3	CGR78
Li <sub>2</sub> UO <sub>4</sub>	381.4	Chad73	H <sub>2</sub> WO <sub>4</sub>	36.2	BiPo73
K <sub>2</sub> UF <sub>6</sub>	382.4	PMDS77	K <sub>2</sub> WO <sub>4</sub>	36.0	NFS82



Li <sub>2</sub> WO <sub>4</sub>	36.0	NFS 82, MSC 73	Zn <sub>3</sub> P <sub>2</sub>	1020.6	NSDU75
Na <sub>2</sub> WO <sub>4</sub>	36.3	Wagn75	ZnP <sub>2</sub>	1020.9	NSDU75
Na <sub>0.6</sub> WO <sub>3</sub>	35.8	BiPo73	ZnI <sub>2</sub>	1023.0	GaWi77, SATD73
Na <sub>0.1</sub> WO <sub>3</sub>	35.6	BiPo73	ZnBr <sub>2</sub>	1023.4	Wagn75, SATD73
NiWO <sub>4</sub>	35.4	NgHe76	ZnCl <sub>2</sub>	1021.9	KIHe83
Rh <sub>2</sub> WO <sub>6</sub>	35.6	NFS82	ZnCl <sub>2</sub>	1023.1	SATD73
(NH <sub>4</sub> ) <sub>6</sub> W <sub>7</sub> O <sub>24</sub> · 4H <sub>2</sub> O	36.3	BiPo73	ZnF <sub>2</sub>	1022.2	GaWi77
K <sub>2</sub> WCl <sub>6</sub>	34.9	LeBr72	ZnF <sub>2</sub>	1022.8	Wagn75
Cl <sub>4</sub> W(Et <sub>3</sub> P) <sub>2</sub>	34.6	LeBr72	ZnO	1021.8	Scho73a, WRDM79
Cl <sub>3</sub> SnW(CO) <sub>3</sub> (C <sub>5</sub> H <sub>5</sub> )	32.4	WWVV77	ZnO	1022.5	GaWi77
Ph <sub>3</sub> PW(CO) <sub>5</sub>	31.6	HVV79	Zn(acac) <sub>2</sub>	1021.4	Wagn75
			(Me <sub>4</sub> N) <sub>2</sub> ZnBr <sub>4</sub>	1020.9	EMGK74
			ZnSO <sub>4</sub>	1023.1	Nefe82
<b>Xe 3d<sub>5/2</sub></b>			Zn <sub>4</sub> Si <sub>2</sub> O <sub>7</sub> (OH) <sub>2</sub> · 2H <sub>2</sub> O	1022.0	WPHK82
Xe in graphite	669.7	Φ	ZnCr <sub>2</sub> O <sub>4</sub>	1022.1	BDFP81
Xe in Ag	669.6	CiHa74	ZnRh <sub>2</sub> O <sub>4</sub>	1021.7	NFS82
Xe in Au	668.9	CiHa74			
Xe in Cu	669.6	CiHa74	<b>Zn LMM</b>		
Xe in Fe	670.2	Wagn75	Zn	992.1	GaWi77, KLMP74, MaDu77, Scho73a, KPML73, KIHe83
Xe in graphite	669.7	WRDM79	Zn	992.1	WRDM79, Wagn75
Na <sub>4</sub> XeO <sub>6</sub>	674.1	Wagn77	Cu <sub>64</sub> Zn <sub>36</sub>	992.7	VanO77
<b>Xe MNN</b>			ZnS	989.7	GaWi77
Xe in Fe	544.8	Wagn75	ZnI <sub>2</sub>	988.7	GaWi77
Xe in graphite	545.2	WRDM79	ZnBr <sub>2</sub>	987.3	Wagn75
Na <sub>4</sub> XeO <sub>6</sub>	541.4	Wagn77	ZnCl <sub>2</sub>	989.4	KIHe83
<b>Y 3d</b>			ZnF <sub>2</sub>	986.2	GaWi77
Y	156.0	Φ	ZnF <sub>2</sub>	986.7	Wagn75
Y	155.8	NyMa80	ZnO	988.5	Scho73a
Y <sub>2</sub> O <sub>3</sub>	156.8	WRDM79, NGDS75	ZnO	987.7	GaWi77
			ZnO	988.2	KIHe83
<b>Yb 4d</b>			Zn(acac) <sub>2</sub>	987.7	Wagn75
Yb	182.4	Φ	Zn <sub>4</sub> Si <sub>2</sub> O <sub>7</sub> (OH) <sub>2</sub> · 2H <sub>2</sub> O	987.3	WPHK82
Yb	181.3	HHL70, KEML74			
Yb	182.7	LPWF75	<b>Zr 3d</b>		
Yb <sub>2</sub> O <sub>3</sub>	185.4	HHL70	Zr	178.9	Φ
<b>Zn 2p<sub>3/2</sub></b>			Zr	178.8	NyMa80
Zn	1021.8	Φ	Zr	178.3	NSCP74
Zn	1021.9	LANM81, LKMP73	ZrO <sub>2</sub>	178.9	WRDM79
Zn	1021.8	GaWi77, KLMP74, MaDu77, Scho73a, KPML73, KIHe83	ZrF <sub>5</sub>	182.2	SaRa80, NGDS75, NSCP74
Zn	1021.8	WRDM79, Wagn75, SMKM77	K <sub>2</sub> ZrF <sub>6</sub>	185.3	NKBP73
Zn	1021.8	VanO77	K <sub>3</sub> ZrF <sub>7</sub>	184.2	NKBP73
Cu <sub>64</sub> Zn <sub>36</sub>	1021.6	GaWi77	KZrF <sub>5</sub> · H <sub>2</sub> O	183.7	NKBP73
ZnS	1022.0		Br <sub>2</sub> Zr(OH) <sub>2</sub> CH <sub>3</sub> CH <sub>2</sub> NH <sub>2</sub> C	184.7	NKBP73
			Cl <sub>2</sub> Zr(OH) <sub>2</sub> CH <sub>3</sub> CH <sub>2</sub> NH <sub>2</sub> C	182.9	KNPP74
				183.0	KNPP74

## Appendix C. Chemical States Tables References

Note: The references in the Chemical States Tables are made with three or four letters which represent the authors' initials. Three or four capital letters indicate three or more authors; alternating upper- and lower-case letters represent two authors (the letters are the first two letters of each last name); and a capital letter followed by three lower case letters indicates a single author. The initials are followed by two digits, which represent the last two digits of the year of publication. This may be followed by a small letter, to distinguish between two otherwise identical reference notations.

- |        |  |        |  |
|--------|--|--------|--|
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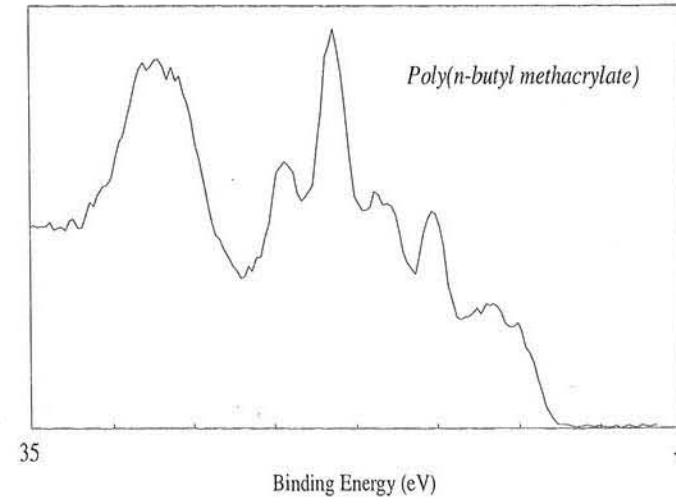
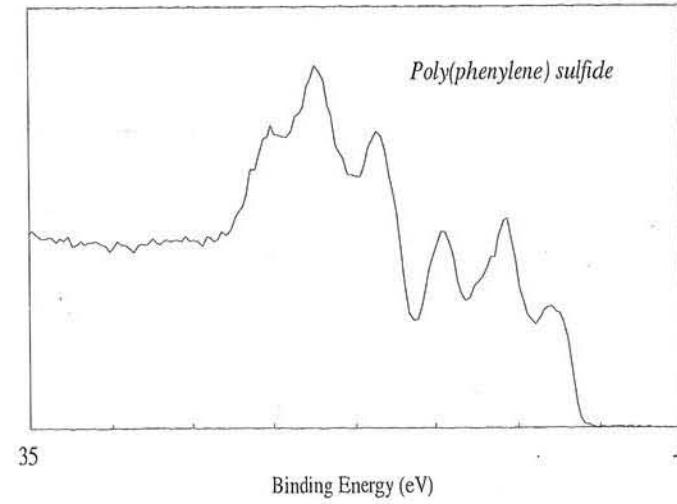
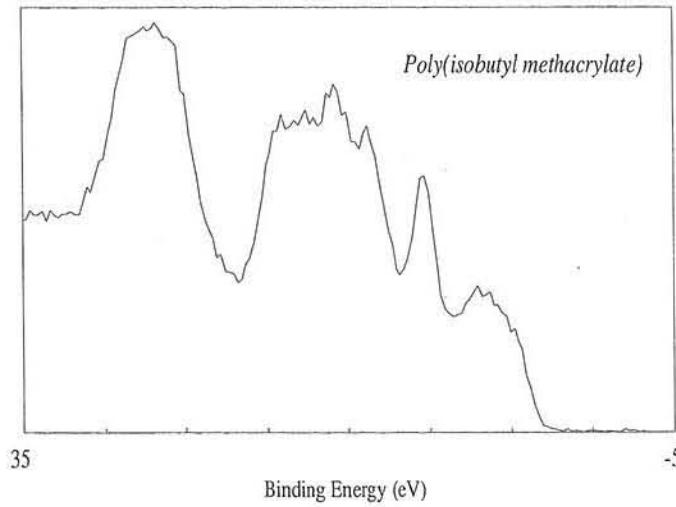
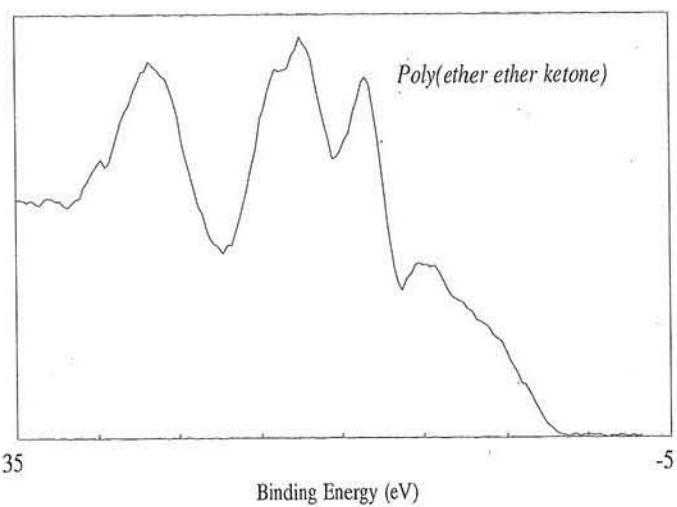
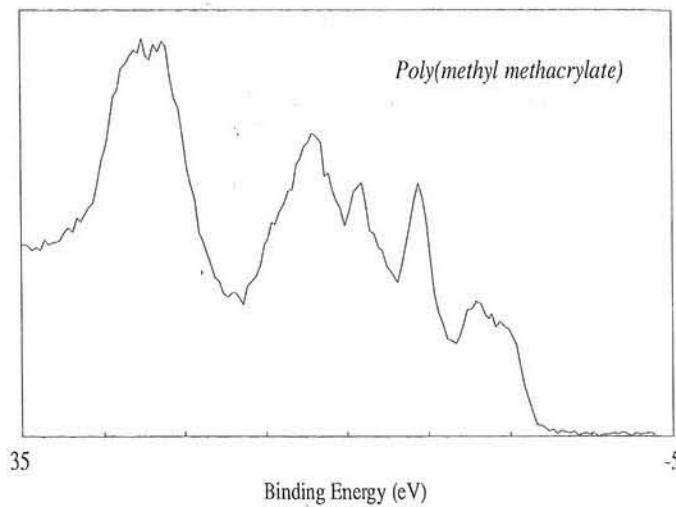
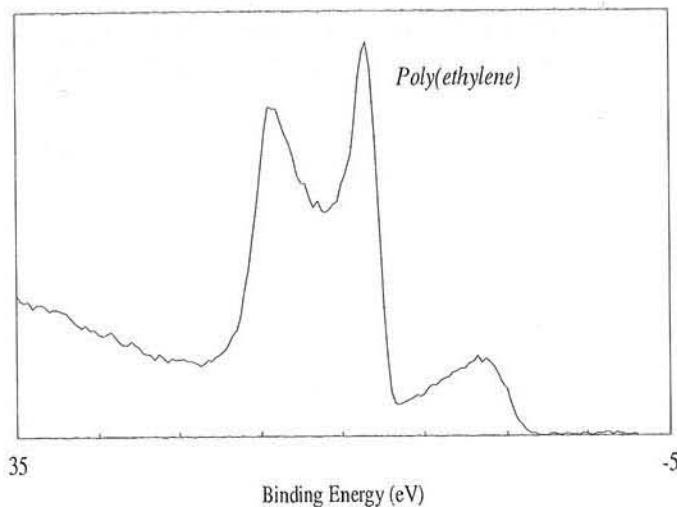
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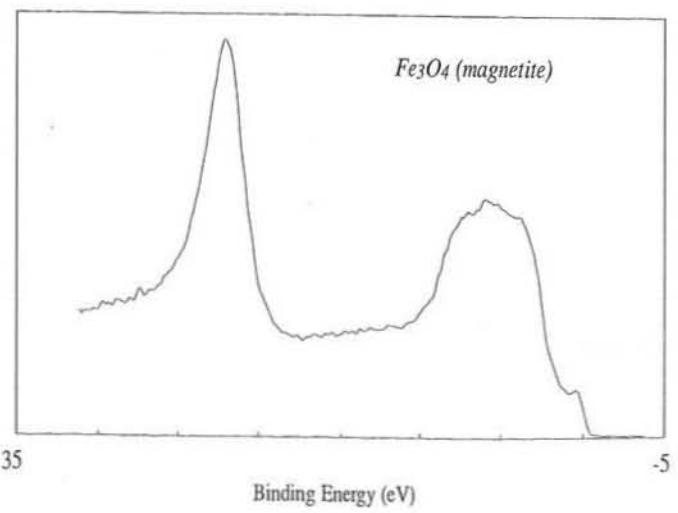
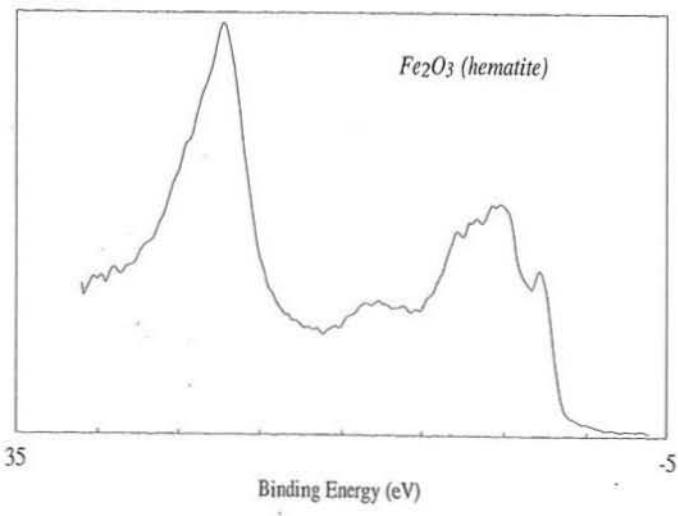
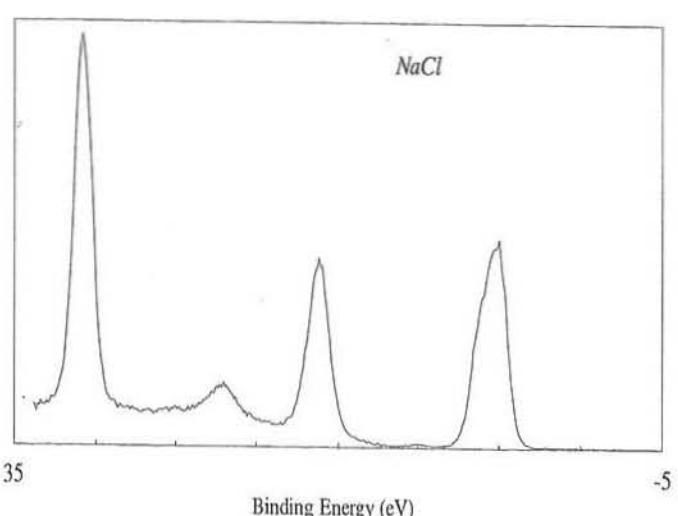
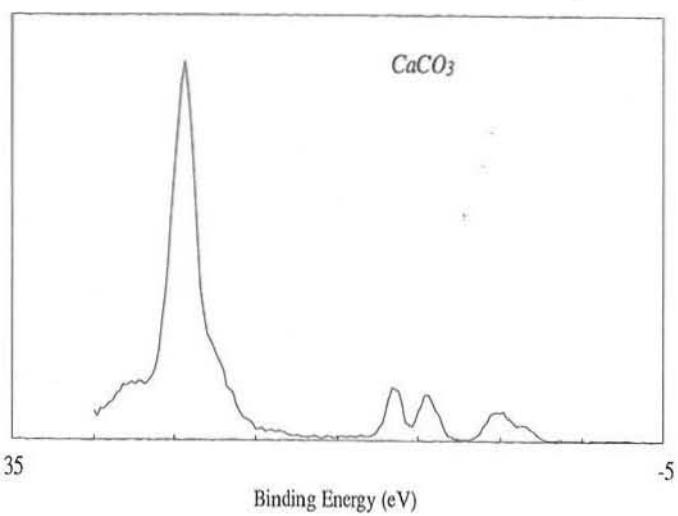
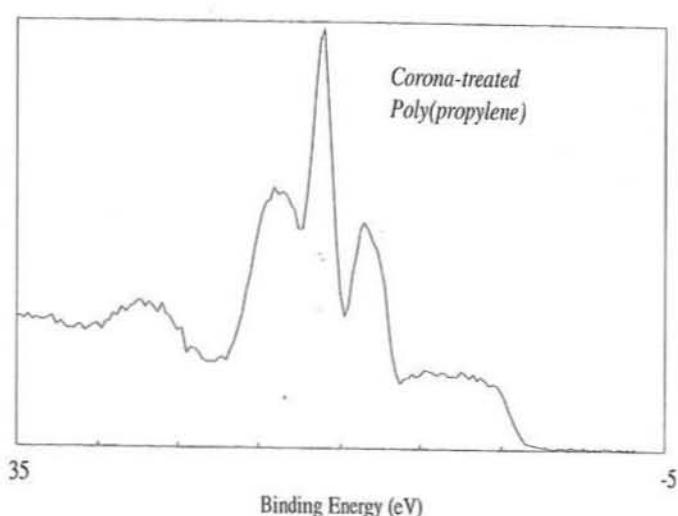
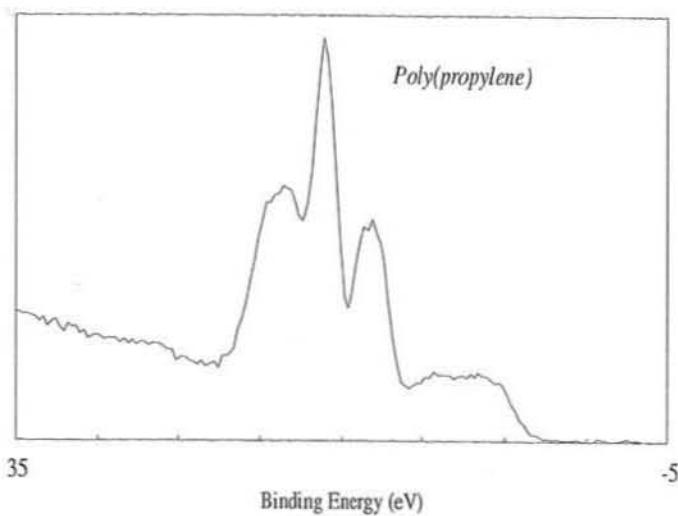
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## Appendix D. Valence Band Spectra

In some cases, the chemical shifts observed in core level XPS are not sufficient to identify the surface chemistry of a particular sample. In the case of XPS analysis of polymers, the changes in carbon chemistry may be quite subtle in core level XPS or the chemical shifts may be only a secondary or tertiary effect. With the routine use of monochromators in XPS and the high counting rates made possible by current spectrometer technologies, many analysts use valence bands for identification of materials. In many cases, the valence bands are used as fingerprints for a sample or a surface treatment, rather than for identifying specific molecular orbitals. The fingerprints of the valence bands may then be used to aid in both the identification of polymers and the quantification of polymer mixtures by using methods such as linear least squares fitting. The following is a small compilation of valence band spectra of organic and inorganic materials to illustrate the utility of valence band data.





## Appendix E. Atomic Sensitivity Factors for X-ray Sources at 90°

This table is based upon empirical peak area values\* corrected for the system's transmission function. The values are only valid for and should only be applied when the electron energy analyzer used has the transmission characteristics of the spherical capacitor type analyzer equipped with an Omni Focus III lens supplied by Perkin-Elmer. The data are calculated for x-rays at 90° relative to the analyzer.

Element	Line	ASF									
Ag	3d	5.198	Eu	4d	2.210	Na	1s	1.685	Si	2p	0.283
Al	2p	0.193	F	1s	1.000	Nb	3d	2.517	Sm	3d <sub>5/2</sub>	2.907
Ar	2p	1.011	Fe	2p	2.686	Nd	3d	4.697	Sn	3d <sub>5/2</sub>	4.095
As	3d	0.570	Ga	2p <sub>3/2</sub>	3.341	Ne	1s	1.340	Sr	3d	1.578
Au	4f	5.240	Gd	4d	2.207	Ni	2p	3.653	Ta	4f	2.589
B	1s	0.159	Ge	2p <sub>3/2</sub>	3.100	O	1s	0.711	Tb	4d	2.201
Ba	4d	2.627	Hf	4f	2.221	Os	4f	3.747	Tc	3d	3.266
Be	1s	0.074	Hg	4f	5.797	P	2p	0.412	Te	3d <sub>5/2</sub>	4.925
Bi	4f	7.632	Ho	4d	2.189	Pb	4f	6.968	Th	4f <sub>7/2</sub>	7.498
Br	3d	0.895	I	3d <sub>5/2</sub>	5.337	Pd	3d	4.642	Ti	2p	1.798
C	1s	0.296	In	3d <sub>5/2</sub>	3.777	Pm	3d	3.754	Tl	4f	6.447
Ca	2p	1.634	Ir	4f	4.217	Pr	3d	6.356	Tm	4d	2.172
Cd	3d <sub>5/2</sub>	3.444	K	2p	1.300	Pt	4f	4.674	U	4f <sub>7/2</sub>	8.476
Ce	3d	7.399	Kr	3d	1.096	Rb	3d	1.316	V	2p	1.912
Cl	2p	0.770	La	3d	7.708	Re	4f	3.327	W	4f	2.959
Co	2p	3.255	Li	1s	0.025	Rh	3d	4.179	Xe	3d <sub>5/2</sub>	5.702
Cr	2p	2.201	Lu	4d	2.156	Ru	3d	3.696	Y	3d	1.867
Cs	3d <sub>5/2</sub>	6.032	Mg	2s	0.252	S	2p	0.570	Yb	4d	2.169
Cu	2p	4.798	Mn	2p	2.420	Sb	3d <sub>5/2</sub>	4.473	Zn	2p <sub>3/2</sub>	3.354
Dy	4d	2.198	Mo	3d	2.867	Sc	2p	1.678	Zr	3d	2.216
Er	4d	2.184	N	1s	0.477	Se	3d	0.722			

\*C.D Wagner, et al. *Surf. Interface Anal.* 3, 211 (1981).

## Appendix F. Atomic Sensitivity Factors for X-ray Sources at 54.7°

This table is based upon empirical peak area values\* corrected for the system's transmission function. The values are only valid for and should only be applied when the electron energy analyzer used has the transmission characteristics of the spherical capacitor type analyzer equipped with an Omni Focus III lens supplied by Perkin-Elmer. The data are calculated for x-rays at 54.7° relative to the analyzer.

Element	Line	ASF									
Ag	3d	5.987	Eu	4d	2.488	Na	1s	1.685	Si	2p	0.339
Al	2p	0.234	F	1s	1.000	Nb	3d	2.921	Sm	3d <sub>5/2</sub>	3.611
Ar	2p	1.155	Fe	2p	2.957	Nd	3d	5.671	Sn	3d <sub>5/2</sub>	4.725
As	3d	0.677	Ga	2p <sub>3/2</sub>	3.720	Ne	1s	1.340	Sr	3d	1.843
Au	4f	6.250	Gd	4d	2.484	Ni	2p	4.044	Ta	4f	3.082
B	1s	0.159	Ge	2p <sub>3/2</sub>	3.457	O	1s	0.711	Tb	4d	2.477
Ba	3d <sub>5/2</sub>	7.469	Hf	4f	2.639	Os	4f	4.461	Tc	3d	3.776
Be	1s	0.074	Hg	4f	6.915	P	2p	0.486	Te	3d <sub>5/2</sub>	5.705
Bi	4f	9.140	Ho	4d	2.469	Pb	4f	8.329	Th	4f <sub>7/2</sub>	9.089
Br	3d	1.053	I	3d <sub>5/2</sub>	6.206	Pd	3d	5.356	Ti	2p	2.001
C	1s	0.296	In	3d <sub>5/2</sub>	4.359	Pm	3d	4.597	Tl	4f	7.691
Ca	2p	1.833	Ir	4f	5.021	Pr	3d	7.627	Tm	4d	2.454
Cd	3d <sub>5/2</sub>	3.974	K	2p	1.466	Pt	4f	5.575	U	4f <sub>7/2</sub>	10.315
Ce	3d	8.808	Kr	3d	1.287	Rb	3d	1.542	V	2p	2.116
Cl	2p	0.891	La	3d	9.122	Re	4f	3.961	W	4f	3.523
Co	2p	3.590	Li	1s	0.025	Rh	3d	4.822	Xe	3d <sub>5/2</sub>	6.64
Cr	2p	2.427	Lu	4d	2.441	Ru	3d	4.273	Y	3d	2.175
Cs	3d <sub>5/2</sub>	7.041	Mg	2s	0.252	S	2p	0.666	Yb	4d	2.451
Cu	2p	5.321	Mn	2p	2.659	Sb	3d <sub>5/2</sub>	5.176	Zn	2p <sub>3/2</sub>	3.726
Dy	4d	2.474	Mo	3d	3.321	Sc	2p	1.875	Zr	3d	2.576
Er	4d	2.463	N	1s	0.477	Se	3d	0.853			

\*C.D Wagner, et al. *Surf. Interface Anal.* 3, 211 (1981).



## Appendix G. Line Positions<sup>a)</sup> by Element for Al K $\alpha$ X-rays

Atomic Number/Element	Photoelectron Lines										Auger Lines			
	1s	2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	KL <sub>1</sub> L <sub>1</sub>	KL <sub>1</sub> L <sub>23</sub>	KL <sub>23</sub> L <sub>23</sub> <sup>b)</sup>
3 Li		56												
4 Be		112												1384
5 B		189												1310
6 C		285												1223
7 N		398												1107
8 O	531	23										1013	999	978
9 F		685	30									878	859	832
10 Ne		863	41	14								725	702	669
11 Na	1072	64		31								561	532	493
12 Mg	1303	89	50									381	347	301
13 Al		118		73								1419		
14 Si		151	100	99								1394		
15 P		188	131	130	14							1367		
16 S		228	165	164	18							1336		
17 Cl		271	201	199	17	6						1304		
18 Ar		320	244	242	24							1272		
19 K		380	297	294	35	19						1239		
20 Ca		440	351	347	45	26						1197		
21 Sc		499	404	399	51	29						1149	1118	
22 Ti		561	460	454	59	33						1098	1068	
23 V		626	520	512	66	37						1048	1014	977
24 Cr		696	583	574	75	43						997	959	917
25 Mn		769	650	639	83	48						944	900	852
26 Fe		845	720	707	92	53						888	839	784
27 Co		925	793	778	101	60						838	831	713
28 Ni		1009	870	853	111	67						778	772	641
29 Cu		1097	953	933	123	77	75					719	712	624
30 Zn		1195	1045	1022	140	91	89	10				660	652	568
31 Ga		1301	1144	1117	160	107	104	19				597	589	548
32 Ge		1248	1217	181	126	122	30	29				534	525	472
33 As		1359	1324	205	146	141	43	42				371	360	392
34 Se			232	169	163	57	56				M <sub>2</sub> M <sub>4</sub> N <sub>23</sub>	299	287	226
35 Br			256	189	182	70	69	15	5			1390		140
36 Kr			287	216	208	88	87	21	8					
37 Rb			325	249	240	113	111	31	16			1385		
38 Sr			360	281	270	136	134	39	21				M <sub>45</sub> N <sub>23</sub> V	
39 Y			394	311	299	158	156	45	24				1356	
40 Zr			430	343	330	181	179	51	28				1368	1337

a) Lines enclosed in boxes are the ones which are most useful for identifying chemical states.

b) Includes KV designation when L<sub>23</sub> is not a core level.

c) Designation is oversimplified.

d) Includes LVV when M levels are not in core and MVV when N levels are not in core.

e) No simple 4p<sub>1/2</sub> line exists for this group of elements.

f) The 4d doublet for these elements is complex and is variable with chemical state because of multiplet splitting and multi-electron processes.

g) The 5s is of low intensity and is often in the shake-up structure of the 4f lines. These values are estimates of the energy.

Atomic Number/Element	Photoelectron Lines														Auger Lines													
	3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>	4f <sub>5/2</sub>	5s	5p <sub>1/2</sub>	5p <sub>3/2</sub>	5d <sub>3/2</sub>	5d <sub>5/2</sub>	6s	6p <sub>1/2</sub>	6p <sub>3/2</sub>	M <sub>4</sub> N <sub>23</sub> V	M <sub>5</sub> N <sub>48</sub> N <sub>45</sub> <sup>d)</sup>	M <sub>4</sub> N <sub>45</sub> N <sub>45</sub> <sup>d)</sup>	M <sub>4</sub> N <sub>45</sub> V	M <sub>5</sub> VV	M <sub>4</sub> VV			
41 Nb	467	376	361	205	202	56	31														1319	1287						
42 Mo	506	412	394	231	228	63	36														1299	1264						
43 Tc	544	445	425	257	253	68	39														1280	1241						
44 Ru	586	484	462	284	280	75	43 <sup>c)</sup>														1256	1212						
45 Rh	629	521	497	312	307	81	48														1234	1185						
46 Pd	671	560	533	340	335	88	52														1211	1159						
47 Ag	719	604	573	374	368	98	60														1191	1135	1129					
48 Cd	772	652	618	412	405	110	69	11													1110	1084	1076					
49 In	828	703	665	452	444	123	78	17													1058	1049						
50 Sn	885	757	715	493	485	137	89	25													1032	1022						
51 Sb	944	813	767	537	528	153	99	33													1005	995						
52 Te	1009	871	820	583	573	170	111	42	41			12									982	971						
53 I	1071	930	875	630	619	187	123	51	49			17									955	942						
54 Xe	1141	996	934	683	670	207	139	63	61			17									931	918						
55 Cs	1219	1069	1002	740	726	234	173	161	80	77		25									900	886						
56 Ba	1292	1138	1064	796	781	254	193	179	93	90		31	15								867	854						
57 La	1208	1128	853	836	825	275	213	197	106	103		34	17								833							
58 Ce	1272	1184	902	884	890	290	223	207	112	109		36	18								797							
59 Pr	1339	1242	952	932	930	305	234	218	115 <sup>b)</sup>			38	18								758							
60 Nd		1301	1003	981	981	320	245	228	121			39	19								714							
61 Pm		1060	1034	337	337	264	242	129				38	22								682							
62 Sm		1108	1081	349	283	250	129					41	19								637							
63 Eu		1155	1126	363	289	255	128					39	19								602							
64 Gd		1218	1186	378	291	272	140		8			43	21								559	411	260	230				
65 Tb		1276	1241	396	322	285	146		8			45	22								526	368						
66 Dy		1333	1296	417	337	297	152		8			48	23								488	314	117					
67 Ho		1393	1352	435	353	309	160		9			49	30	24							440	273	98	56				
68 Er			451	368	321	167		9				52	31	24							398							
69 Tm			470	384	333	175		8				53	32	25														
70 Yb			482	389	341	182		3				51	30	24														
71 Lu			509	413	360	206	196	9	7			57	34	27							N <sub>2</sub> N <sub>57</sub> N <sub>7</sub>	N <sub>4</sub> N <sub>6</sub> N <sub>7</sub>						
72 Hf			534	437	380	222	211	16	14			63	38	30							1317	1306						
73 Ta			563	463	401	238	226	24	22			69	43	33							1316	1306						
74 W			594	491	424	256	243	33	31			75	47	37							1320	1307						
75 Re			625	518	446	274	260	42	40			99									1322	1309						
76 Os			658	548	471	293	279	54	51	89 <sup>b)</sup>		44									1326	1311						
77 Ir			692	578	495	312	297	64	61	96 <sup>b)</sup>		48									1329	1314						
78 Pt			725	609	520	332	315	74	71	103 <sup>b)</sup>		52									1334	1317	N <sub>2</sub> N <sub>7</sub> O	N <sub>4</sub> N <sub>6</sub> O	N <sub>7</sub> O <sub>45</sub> O <sub>4</sub>	N <sub>6</sub> O <sub>45</sub> O <sub>45</sub>		
79 Au			763	643	547	353	335	88	84	110 <sup>b)</sup>		57	74								1342	1324	1247	1231	1416			
80 Hg			805	682	579	381	361	105	101	125 <sup>b)</sup>		85	67	12	10						1336	1246	1230	1412	1406			
81 Tl			847	720	610	406	385	122	118	133 <sup>b)</sup>		95	74	15	13						1364	1343	1241	1222	1401	1399		
82 Pb			893	762	644	434	412	142	137	150 <sup>b)</sup>		107	84	21	18						1369	1354		1394	1391			
83 Bi			940	806	679	464	440	162	157	161 <sup>b)</sup>		119	93	27	24						N <sub>2</sub> O <sub>23</sub> V	N <sub>6</sub> O <sub>6</sub> V		1387	1383			
90 Th			1330	1170	965	713	676	342	333	294	234	177	93	85	42	25	17				1419	1239		1335	1404			
92 U			1272	1043	779	736	388	377	322	260	195	103	94	44	26	17					1412	1204				1386		
93 Np			1327	1086	816	771	414	402			206		101		29	18												
94 Pu				1121	850	802	439	427			216		105		31	18												
95 Am					883	832	463	449	351		216	119	109		31	18												
96 Cm						919	865	487	473		232		113		32	18												
97 Bk						958	901	514	498		246		120		34	18												
98 Cf						994	933	541	523		124		35		19													

## Appendix H. Line Positions<sup>a)</sup> by Element for Mg K $\alpha$ X-rays

Atomic Number/Element	Photoelectron Lines										Auger Lines			
	1s	2s	2p <sub>1/2</sub>	2p <sub>3/2</sub>	3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	KL <sub>1</sub> L <sub>1</sub>	KL <sub>1</sub> L <sub>23</sub>	KL <sub>23</sub> L <sub>23</sub> <sup>b)</sup>
3 Li	56													
4 Be	112													1151
5 B	189													1077
6 C	285													990
7 N	398													874
8 O	531	23												
9 F	685	30												
10 Ne	863	41		14										
11 Na	1072	64		31										
12 Mg	1303	89		50										
13 Al	118		73											
14 Si	151	100	99											
15 P	188	131	130	14										
16 S	228	165	164	18										
17 Cl	271	201	199	17		6								
18 Ar	320	244	242	24										
19 K	380	297	294	35		19								
20 Ca	440	351	347	45		26								
21 Sc	499	404	399	51		29								
22 Ti	561	460	454	59		33								
23 V	627	520	512	66		37								
24 Cr	696	583	574	75		43								
25 Mn	769	650	639	83		48								
26 Fe	845	720	707	92		53								
27 Co	925	793	778	101		60								
28 Ni	1009	870	853	111		67								
29 Cu	1097	953	933	123	77	75								
30 Zn	1195	1045	1022	140	91	89	10							
31 Ga	1144	1117	160	107	104	19								
32 Ge	1248	1217	181	126	122	30	29							
33 As	205	146	141	43		42								
34 Se	232	169	163	57		56						M <sub>23</sub> M <sub>45</sub> N <sub>23</sub>		
35 Br	256	189	182	70		69	15	5				1157		
36 Kr	287	216	208	88		87	21	8						
37 Rb	325	249	240	113		111	31	16				1152		
38 Sr	360	281	270	136		134	39	21					M <sub>23</sub> N <sub>23</sub> V	
39 Y	394	311	299	158		156	45	24					M <sub>23</sub> N <sub>45</sub> N <sub>45</sub>	1123
40 Zr	430	343	330	181		179	51	28					1160	1104

a) Lines enclosed in boxes are the ones which are most useful for identifying chemical states.

b) Includes KV<sub>V</sub> designation when L<sub>23</sub> is not a core level.

c) Designation is oversimplified.

d) Includes LV<sub>V</sub> when M levels are not in core and MV<sub>V</sub> when N levels are not in core.

e) No simple 4p<sub>1/2</sub> line exists for this group of elements.

f) The 4d doublet for these elements is complex and is variable with chemical state because of multiplet splitting and multi-electron processes.

g) The 5s is of low intensity and is often in the shake-up structure of the 4f lines. These values are estimates of the energy.

Atomic Number/Element												Photoelectron Lines												Auger Lines											
	3s	3p <sub>1/2</sub>	3p <sub>3/2</sub>	3d <sub>3/2</sub>	3d <sub>5/2</sub>	4s	4p <sub>1/2</sub>	4p <sub>3/2</sub>	4d <sub>3/2</sub>	4d <sub>5/2</sub>	4f <sub>5/2</sub>	5s	5p <sub>1/2</sub>	5p <sub>3/2</sub>	5d <sub>3/2</sub>	5d <sub>5/2</sub>	6s	6p <sub>1/2</sub>	6p <sub>3/2</sub>	M <sub>4s</sub> N <sub>23</sub> V	M <sub>5</sub> N <sub>45</sub> N <sub>45</sub> <sup>d)</sup>	M <sub>4</sub> N <sub>45</sub> N <sub>45</sub> <sup>d)</sup>	M <sub>4s</sub> N <sub>45</sub> V	M <sub>5</sub> VV	M <sub>4</sub> VV										
41 Nb	467	376	361	205	202	56	31															1086	1054												
42 Mo	506	412	394	231	228	63	36															1066	1031												
43 Tc	544	445	425	257	253	68	39															1047	1008												
44 Ru	586	484	462	284	280	75	43 <sup>c)</sup>															1023	979												
45 Rh	629	521	497	312	307	81	48															1001	952												
46 Pd	671	560	533	340	335	88	52															978	926												
47 Ag	719	604	573	374	368	98	60															958	902	896											
48 Cd	772	652	618	412	405	110	69	11														877	870												
49 In	828	703	665	452	444	123	78	17														851	843												
50 Sn	885	757	715	493	485	137	89	25														825	816												
51 Sb	944	813	767	537	528	153	99	33														799	789												
52 Te	1009	871	820	583	573	170	111	42	41			12										772	762												
53 I	1071	930	875	630	619	187	123	51	49			18										749	738												
54 Xe	1141	996	934	683	670	207	139	63	61			17										722	709												
55 Cs	1219	1069	1002	740	726	234	173	161	80	77		25										698	685												
56 Ba	1138	1064	976	781	754	193	179	93	90			31	15									667	653												
57 La	1208	1128	853	836	275	213	197	106	103			34	17									634	621												
58 Ce		1184	902	884	290	223	207	112	109			36	18									600													
59 Pr		1242	952	932	305	234	218	115 <sup>b)</sup>				38	18										564												
60 Nd			1003	981	320	245	228	121				39	19										525												
61 Pm			1060	1034	337	264	242	129				38	22										481												
62 Sm		1108	1081	349	283	250	129					41	19										449												
63 Eu		1155	1126	363	289	255	128					39	19										404												
64 Gd		1218	1186	378	291	272	140	8				43	21										369												
65 Tb		1241	396	322	285	146	8	45	22													326	170												
66 Dy			417	337	297	152	8	48	23																										
67 Ho			435	353	309	159	9	49	30	24																									
68 Er			451	368	321	167	9	52	31	24																									
69 Tm			470	384	333	175	8	53	32	25																									
70 Yb			482	389	341	182	3	51	30	24																									
71 Lu			509	413	360	206	196	9	7	57	34	27																							
72 Hf			534	437	380	222	211	16	14	63	38	30																							
73 Ta			563	463	401	238	226	24	22	69	43	33																							
74 W			594	491	424	256	243	33	31	75	47	37																							
75 Re			625	518	446	274	260	42	40	99																									
76 Os			658	548	471	293	279	54	51	89	44																								
77 Ir			692	578	495	312	297	64	61	96 <sup>b)</sup>	48																								
78 Pt			725	609	520	332	315	74	71	103 <sup>b)</sup>	52																								
79 Au			763	643	547	353	335	88	84	110 <sup>b)</sup>	74																								
80 Hg			805	682	579	381	361	107	103	125 <sup>b)</sup>	85	67	12	10																					
81 Tl			847	720	610	406	385	122	118	133 <sup>b)</sup>	95	74	15	13																					
82 Pb			893	762	644	434	412	142	137	150 <sup>b)</sup>	107	84	21	18																					
83 Bi			940	806	679	464	440	162	157	161 <sup>b)</sup>	119	93	27	24																					
90 Th			1170	965	713	676	342	333	294	234	177	93	85	42	25	17																			
92 U			1272	1043	779	736	388	377	322	260	195	103	94	44	26	17																			
93 Np				1086	816	771	414	402			206	101		29	18																				
94 Pu				1121	850	802	439	427			216	105		31	18																				
95 Am					883	832	463	449	351		216	119	109		31	18																			
96 Cm						919	865	487	473		232	113		32	18																				
97 Bk						958	901	514	498		246	120		34	18																				
98 Cf						994	933	541	523			124		35	19																				

## Appendix J. Line Positions in Numerical Order

For photoelectron lines, the spin orbit splitting is indicated in parentheses. Auger lines are in italics, and the photon source for the Auger excitation is indicated in parentheses.

7	Lu 4f <sub>7/2</sub>	(2)	89	Mg 2s		175	Tm 4d		299	Y 3p <sub>3/2</sub>	(12)
14	Hf 4f <sub>7/2</sub>	(2)	90	Ba 4d <sub>5/2</sub>	(3)	179	Zr 3d <sub>5/2</sub>	(2)	301	<i>Mg</i>	(Al)
23	O 2s		98	<i>Er</i>	(Al)	181	<i>Se</i>	(Al)	307	Rh 3d <sub>5/2</sub>	(5)
22	Ta 4f	(2)	99	Si 2p <sub>3/2</sub>	(1)	182	Yb 4d		309	Ho 4p <sub>3/2</sub>	(44)
25	Sn 4d		101	Hg 4f <sub>7/2</sub>	(4)		Br 3p <sub>3/2</sub>	(7)	315	Pt 4d <sub>5/2</sub>	(17)
29	Ge 3d <sub>5/2</sub>	(1)	103	La 4d <sub>5/2</sub>	(3)	186	<i>Ga</i>	(Mg)	320	Ar 2s	
30	F 2s		104	Ga 3p <sub>3/2</sub>	(3)	188	P 2s		321	Er 4p <sub>3/2</sub>	(47)
31	W 4f <sub>7/2</sub>	(2)	109	Ce 4d <sub>5/2</sub>	(3)	189	B 1s		330	Zr 3p <sub>3/2</sub>	(14)
37	V 3p			<i>Ge</i>	(Mg)	196	Lu 4d <sub>5/2</sub>	(10)	333	Th 4f <sub>7/2</sub>	(9)
40	Re 4f <sub>7/2</sub>	(2)	112	Rb 3d <sub>5/2</sub>	(1)	199	Cl 2p <sub>3/2</sub>	(2)		Tm 4p <sub>3/2</sub>	(51)
41	Ne 2s			Be 1s		202	Nb 3d <sub>5/2</sub>	(3)	335	Pd 3d <sub>5/2</sub>	(5)
42	As 3d <sub>5/2</sub>	(1)	115	Pr 4d		208	Kr 3p <sub>3/2</sub>	(8)		Au 4d <sub>5/2</sub>	(18)
43	Cr 3p		117	<i>Ho</i>	(Al)	211	Hf 4d <sub>5/2</sub>	(11)		<i>Cu</i>	(Mg)
48	Mn 3p		118	Tl 4f <sub>7/2</sub>	(4)	226	Ta 4d <sub>5/2</sub>	(12)	341	Yb 4p <sub>3/2</sub>	(48)
49	I 4d <sub>5/2</sub>	(2)		Al 2s		228	S 2s		342	<i>Ge</i>	(Al)
50	Mg 2p		121	Nd 4d			Mo 3d <sub>5/2</sub>	(3)	347	Ca 2p <sub>3/2</sub>	(3)
51	Os 4f <sub>7/2</sub>	(3)	122	Ge 3p <sub>3/2</sub>	(4)	240	Rb 3p <sub>3/2</sub>	(9)	360	Lu 4p <sub>3/2</sub>	(53)
53	Fe 3p		128	Eu 4d		242	Ar 2p <sub>3/2</sub>	(2)	361	Hg 4d <sub>5/2</sub>	(20)
56	Li 1s		129	Sm 4d		243	W 4d <sub>5/2</sub>	(13)		Nb 3p <sub>3/2</sub>	(15)
	Se 3d <sub>5/2</sub>	(1)	131	P 2p <sub>3/2</sub>	(1)	260	Re 4d <sub>5/2</sub>	(14)	368	Ag 3d <sub>5/2</sub>	(6)
60	Co 3p		134	Sr 3d <sub>5/2</sub>	(2)		<i>Na</i>	(Mg)	369	<i>Gd</i>	(Mg)
61	Ir 4f <sub>7/2</sub>	(3)	137	Pb 4f <sub>7/2</sub>	(5)		<i>Tb</i>	(Al)	377	U 4f <sub>7/2</sub>	(11)
	Xe 4d <sub>5/2</sub>	(2)	140	Gd 4d		262	Zn	(Mg)	380	K 2s	
64	Na 2s		141	As 3p <sub>3/2</sub>	(5)		<i>As</i>	(Al)	385	Tl 4d <sub>5/2</sub>	(21)
67	Ni 3p		146	Tb 4d		270	Sr 3p <sub>3/2</sub>	(11)	394	Mo 3p <sub>3/2</sub>	(17)
69	Br 3d <sub>5/2</sub>	(1)	151	Si 2s		271	Cl 2s		398	N 1s	
71	Pt 4f <sub>7/2</sub>	(3)	152	Dy 4d		279	Os 4d <sub>5/2</sub>	(14)	399	Sc 2p <sub>3/2</sub>	(5)
73	Al 2p		156	Y 3d <sub>5/2</sub>	(2)	280	Ru 3d <sub>5/2</sub>	(4)	404	<i>Eu</i>	(Mg)
75	Cu 3p <sub>3/2</sub>	(2)	157	Bi 4f <sub>7/2</sub>	(5)	285	Tb 4p <sub>3/2</sub>	(37)	405	Cd 3d <sub>5/2</sub>	(7)
77	Cs 4d <sub>5/2</sub>	(3)	160	Ho 4d			C 1s		408	<i>Ni</i>	(Mg)
84	Au 4f <sub>7/2</sub>	(4)	163	Se 3p <sub>3/2</sub>	(6)	294	K 2p <sub>3/2</sub>	(3)	412	Pb 4d <sub>5/2</sub>	(22)
87	Kr 3d <sub>5/2</sub>	(1)	164	S 2p <sub>3/2</sub>	(1)	297	Dy 4p <sub>3/2</sub>	(40)	419	<i>Ga</i>	(Al)
89	Zn 3p <sub>3/2</sub>	(2)	167	Er 4d			Ir 4d <sub>5/2</sub>	(15)	436	<i>Ne</i>	(Mg)

440	Ca 2s		669	Ne	(Al)	874	N	(Mg)	1103	Cd	(Al)
449	Sm	(Mg)	670	Xe 3d <sub>5/2</sub>	(13)	884	Ce 3d <sub>5/2</sub>	(18)	1107	N	(Al)
441	Bi 4d <sub>5/2</sub>	(24)	676	Th 4d <sub>5/2</sub>	(37)	886	Ba	(Al)	1117	Ga 2p <sub>3/2</sub>	(27)
444	In 3d <sub>5/2</sub>	(8)	682	Sm	(Al)	896	Ag	(Mg)	1126	Eu 3d <sub>5/2</sub>	(30)
454	Ti 2p <sub>3/2</sub>	(6)	685	F 1s		900	Mn	(Al)	1129	Ag	(Al)
462	Ru 3p <sub>3/2</sub>	(22)		Cs	(Mg)	916	Sc	(Mg)	1149	Sc	(Al)
480	Co	(Mg)	696	Cr 2s		918	Cs	(Al)	1154	Bi	(Mg)
485	Sn 3d <sub>5/2</sub>	(8)	707	Fe 2p <sub>3/2</sub>	(13)	926	Pd	(Mg)	1159	Pd	(Al)
493	Na	(Al)	709	Xe	(Mg)	932	Pr 3d <sub>5/2</sub>	(20)	1161	Pb	(Mg)
495	Zn	(Al)	713	Co	(Al)	933	Cu 2p <sub>3/2</sub>	(20)	1168	Tl	(Mg)
497	Rh 3p <sub>3/2</sub>	(24)	715	Sn 3p <sub>3/2</sub>	(42)	942	Xe	(Al)	1179	Hg	(Mg)
499	Sc 2s		726	Cs 3d <sub>5/2</sub>	(14)	952	Rh	(Mg)	1183	Au	(Mg)
512	V 2p <sub>3/2</sub>	(8)		Cr	(Mg)	959	Cr	(Al)	1185	Rh	(Al)
525	Nd	(Mg)	736	U 4d <sub>5/2</sub>	(42)	964	Ca	(Mg)	1186	Gd 3d <sub>5/2</sub>	(32)
526	Dy	(Al)	738	I	(Mg)	971	U	(Mg)	1197	Ca	(Al)
528	Sb 3d <sub>5/2</sub>	(9)	745	O	(Mg)		I	(Al)	1204	U	(Al)
531	O 1s		758	Nd	(Al)	978	O	(Al)	1212	Ru	(Al)
533	Pd 3p <sub>3/2</sub>	(27)	767	Sb 3p <sub>3/2</sub>	(46)	979	Ru	(Mg)	1217	Ge 2p <sub>3/2</sub>	(31)
551	Fe	(Mg)	772	Te	(Mg)	981	Nd 3d <sub>5/2</sub>	(21)	1223	C	(Al)
561	Ti 2s		778	Co 2p <sub>3/2</sub>	(15)	990	C	(Mg)	1239	Th	(Al)
564	Pr	(Mg)	781	Ba 3d <sub>5/2</sub>	(15)	1005	Te	(Al)		K	(Al)
568	Cu	(Al)		V	(Mg)	1006	K	(Mg)	1241	Tb 3d <sub>5/2</sub>	(35)
573	Ag 3p <sub>3/2</sub>	(31)	784	Fe	(Al)		Th	(Mg)	1272	Ar	(Al)
	Te 3d <sub>5/2</sub>	(10)	797	Pr	(Al)	1014	V	(Al)	1296	Dy 3d <sub>5/2</sub>	(37)
574	Cr 2p <sub>3/2</sub>	(9)	799	Sb	(Mg)	1022	Zn 2p <sub>3/2</sub>	(23)	1299	Mo	(Al)
599	F	(Mg)	816	Sn	(Mg)	1032	Sb	(Al)	1303	Mg 1s	
600	Ce	(Mg)	820	Te 3p <sub>3/2</sub>	(51)	1039	Ar	(Mg)	1304	Cl	(Al)
602	Gd	(Al)	832	F	(Al)	1049	Sn	(Al)	1310	B	(Al)
619	Cd 3p <sub>3/2</sub>	(34)	833	Ce	(Al)	1068	Ti	(Al)	1319	Nb	(Al)
	I 3d <sub>5/2</sub>	(12)	835	Ti	(Mg)	1071	Cl	(Mg)	1324	As 2p <sub>3/2</sub>	(35)
634	La	(Mg)	836	La 3d <sub>5/2</sub>	(17)	1072	Na 1s		1336	S	(Al)
637	Eu	(Al)	843	In	(Mg)	1076	In	(Al)	1387	Bi	(Al)
639	Mn 2p <sub>3/2</sub>	(11)	853	Ni 2p <sub>3/2</sub>	(18)	1077	B	(Mg)	1394	Pb	(Al)
641	Ni	(Al)	863	Ne 1s		1081	Sm 3d <sub>5/2</sub>	(27)	1401	Tl	(Al)
653	Ba	(Mg)	867	La	(Al)	1086	Nb	(Mg)	1412	Hg	(Al)
665	In 3p <sub>3/2</sub>	(38)	870	Cd	(Mg)	1103	S	(Mg)	1416	Au	(Al)
667	Mn	(Mg)									



## Appendix K. Periodic Table

			Atomic number <b>9</b> <b>F</b> 1s      685 KLL     647	PHI sensitivity factor* for designated photoelectron transition 1.0													
				Element symbol													
<b>1</b> <b>H</b>																	
				Most intense photoelectron transition Most intense Auger transition													
				Binding energy, most intense photoelectron transition Kinetic energy, most intense Auger transition													
				<b>2</b> <b>He</b>													
3 0.025	4 0.074																
Li	Be																
1s    56	1s    112																
KLL   43	KLL   103																
11 1.685	12 0.252																
Na	Mg																
1s   1072	2p    50																
KLL   994	KLL   1186																
19 1.30	20 1.634	21 1.678	22 1.798	23 1.912	24 2.201	25 2.42	26 2.686	27 3.255	28 3.653	29 4.798	30 3.354	31 3.341	32 3.100	33 0.570	34 0.722	35 0.895	36 1.096
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
2p    294	2p    347	2p    399	2p    454	2p    512	2p    574	2p    638	2p    707	2p    778	2p    853	2p    933	2p <sub>3/2</sub> 1022	2p <sub>3/2</sub> 1117	2p <sub>3/2</sub> 1217	3d    42	3d    56	3d    69	3d    87
LMM   248	LMM   290	LMM   338	LMM   398	LMM   419	LMM   473	LMM   528	LMM   587	LMM   703	LMM   774	LMM   846	LMM   919	LMM   992	LMM   1068	LMM   1145	MNN   1306	MNN   97	
37 1.316	38 1.578	39 1.867	40 2.216	41 2.517	42 2.867	43 3.266	44 3.696	45 4.179	46 4.643	47 5.198	48 3.444	49 3.777	50 4.095	51 4.473	52 4.925	53 5.337	54 5.702
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
3d    111	3d    134	3d    156	3d    179	3d    202	3d    228	3d    253	3d    280	3d    307	3d    335	3d    368	3d <sub>5/2</sub> 405	3d <sub>5/2</sub> 444	3d <sub>5/2</sub> 485	3d <sub>5/2</sub> 528	3d <sub>5/2</sub> 573	3d <sub>5/2</sub> 619	3d <sub>5/2</sub> 670
MNN   102	MNN   131	MNN   150	MNN   179	MNN   202	MNN   228	MNN   246	MNN   275	MNN   302	MNN   328	MNN   358	MNN   384	MNN   411	MNN   438	MNN   465	MNN   492	MNN   516	MNN   545
55 6.032	56 6.361	57 7.708	72 2.221	73 2.589	74 2.959	75 3.327	76 3.747	77 4.217	78 4.674	79 5.240	80 5.797	81 6.447	82 6.968	83 7.632	84	85	86
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
3ds <sub>2</sub> 726	3ds <sub>2</sub> 781	3d    836	4f    14	4f    22	4f    31	4f    40	4f    51	4f    61	4f    71	4f    84	4f    101	4f    118	4f    137	4f    157			
MNN   569	MNN   601	MNN   633	NNN   181	NNN   181	NNN   180	NNN   178	NNN   176	NNN   153	NNN   170	NNN   163	NOO   81	NOO   88	NOO   96	NOO   104			
87	88	89															
Fr	Ra	Ac															
			58 7.399	59 6.356	60 4.697	61 3.754	62 2.907	63 2.210	64 2.207	65 2.201	66 2.198	67 2.189	68 2.184	69 2.172	70 2.169	71 2.156	
			Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
			3d    884	3d    932	3d    981	3d    1034	3ds <sub>2</sub> 1081	4d    128	4d    140	4d    146	4d    152	4d    160	4d    167	4d    175	4d    182	4f    7	
			MNN   654	MNN   690	MNN   729	MNN   773	MNN   805	MNN   850	MNN   885	MNN   1076	MVV   1119	MVV   1173	MVV   1214				
			90 7.498	91	92 8.476	93	94	95	96	97	98	99	100	101	102	103	
			4f <sub>7/2</sub> 333		4f <sub>7/2</sub> 337		4f <sub>7/2</sub> 337										
			NOV   68		NOV   75												

\*The values are for area measurements of the designated transitions and are only valid when the electron energy analyzer used has the transmission characteristics of the spherical capacitor type analyzer equipped with an Omni Focus III lens supplied by Perkin-Elmer and with x-rays at 90° relative to the analyzer. Where a spin-orbit splitting is not designated the value is for a measurement including both spin-orbit components.