

PMI

POSITIVE MATERIALS IDENTIFICATION



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INTRODUCTION



- Positive Material Identification (PMI) is a quick and non-destructive method used to check the composition of materials. Using tools like X-ray or optical analyzers, PMI helps identify the elements in a material, ensuring it meets required standards. This process is important in industries like construction, oil and gas, and manufacturing to avoid mistakes, ensure safety, and maintain quality.

STANDARD



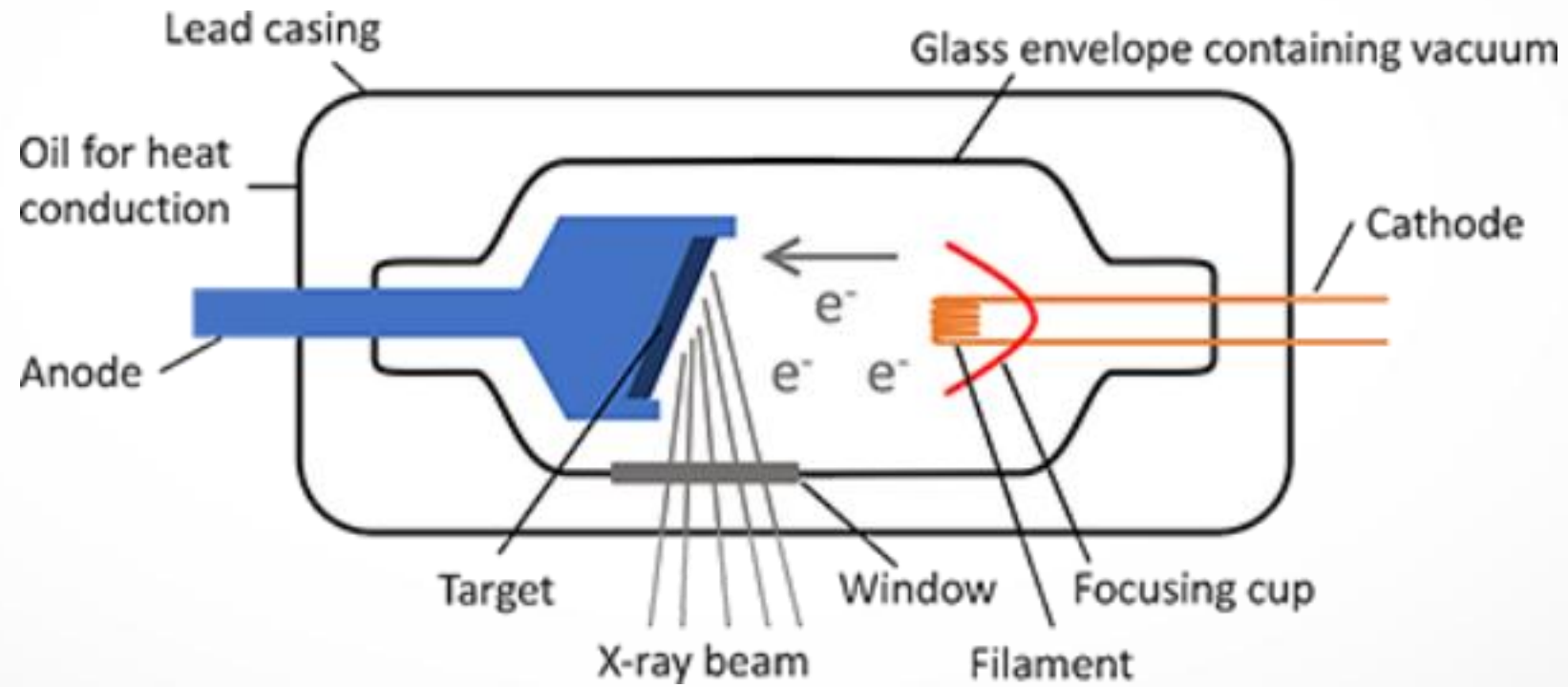
- ASME Sec II Part A Edition 2023
- ASME Sec II Part C Edition 2023
- ASME Sec I NONMANDATORY APPENDIX B
- ASME Sec IX

What is XRF



- XRF → X - Ray fluorescence
- X-ray fluorescence is a non-destructive analytical technique that uses the interaction of X-rays with a material to determine its elemental composition by measuring the fluorescent (or secondary) X-rays emitted when a sample is excited by a primary X-ray source.

X - Ray



Working

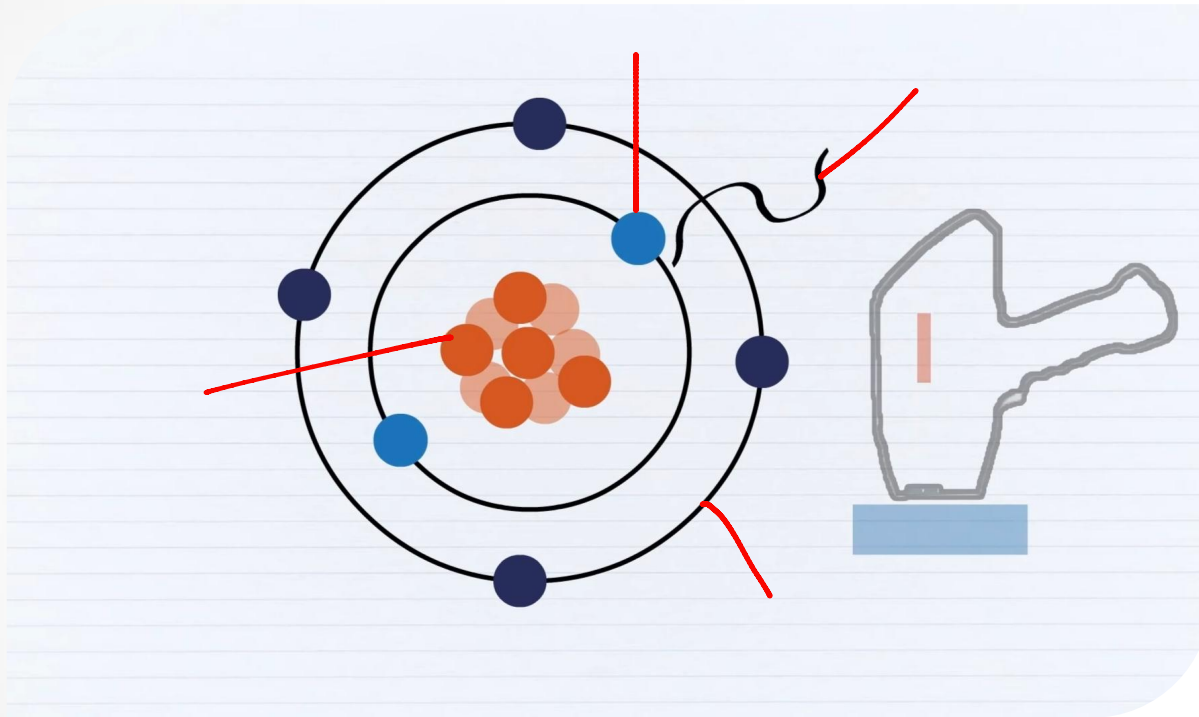


- ***Electron Generation (Cathode):*** In an X-ray tube, *a heated cathode (a filament) emits electrons and this process is called* thermionic emission.
- ***Electron Acceleration:*** A high voltage (between 30-150 kV) is applied between the cathode and the anode. *This accelerates the electrons toward the anode.*

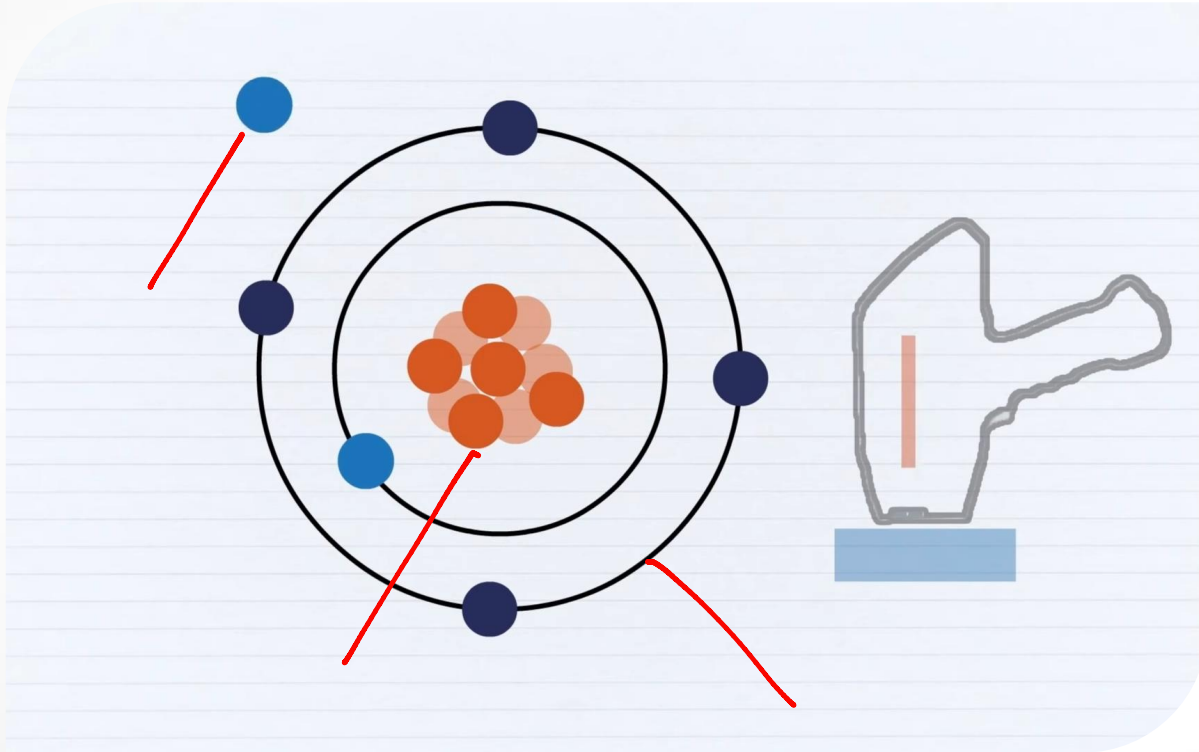


- ***Electron Collision (Anode):*** The accelerated *electrons strike a target material (usually tungsten) anode this cause deacceleration*. This sudden deceleration causes the electrons to lose energy, *emitting X-rays*.
- ***Photoionization:*** When the X-rays interact with the atoms in a material (the sample), they eject electrons from the inner shells of the atoms (typically the K-shell). This is called photoionization.

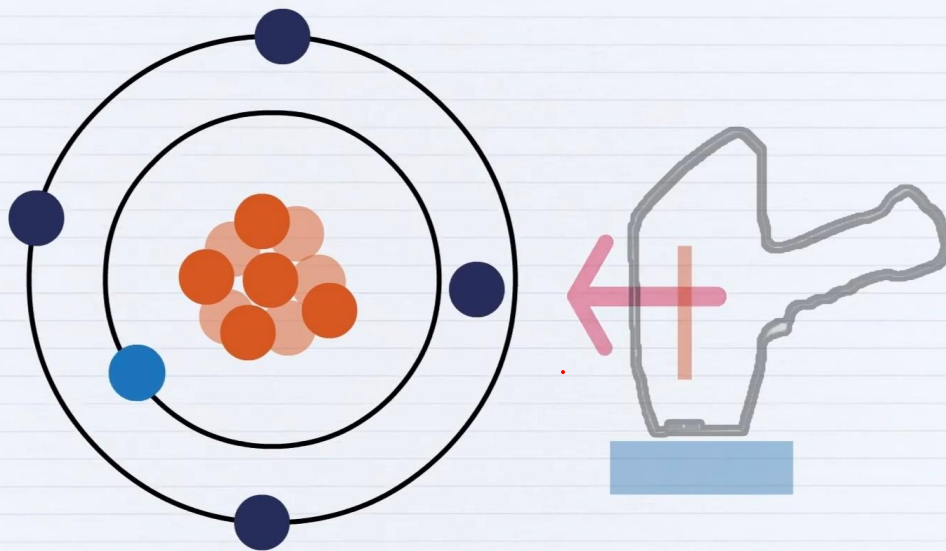
Working Principle



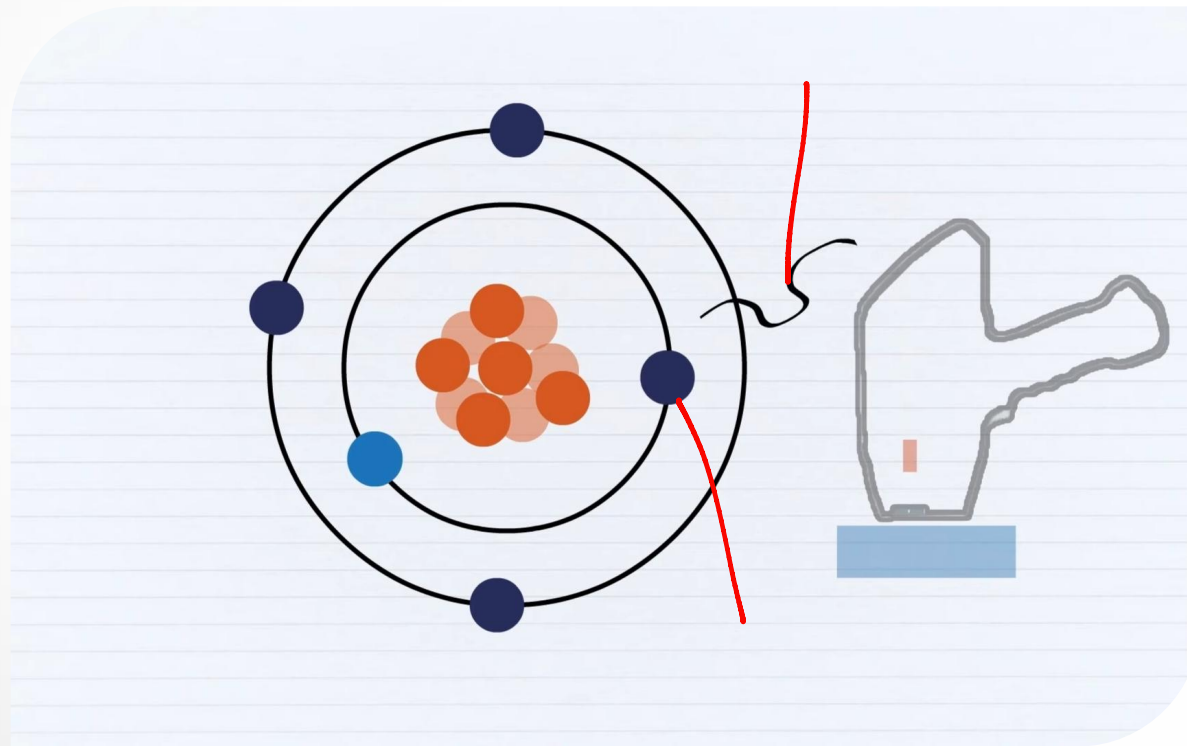
X-Ray Source: X-ray strike the electron in shell.



Emmited the electron : When x ray strikes the K shell electron, it is **escapes** from shell.



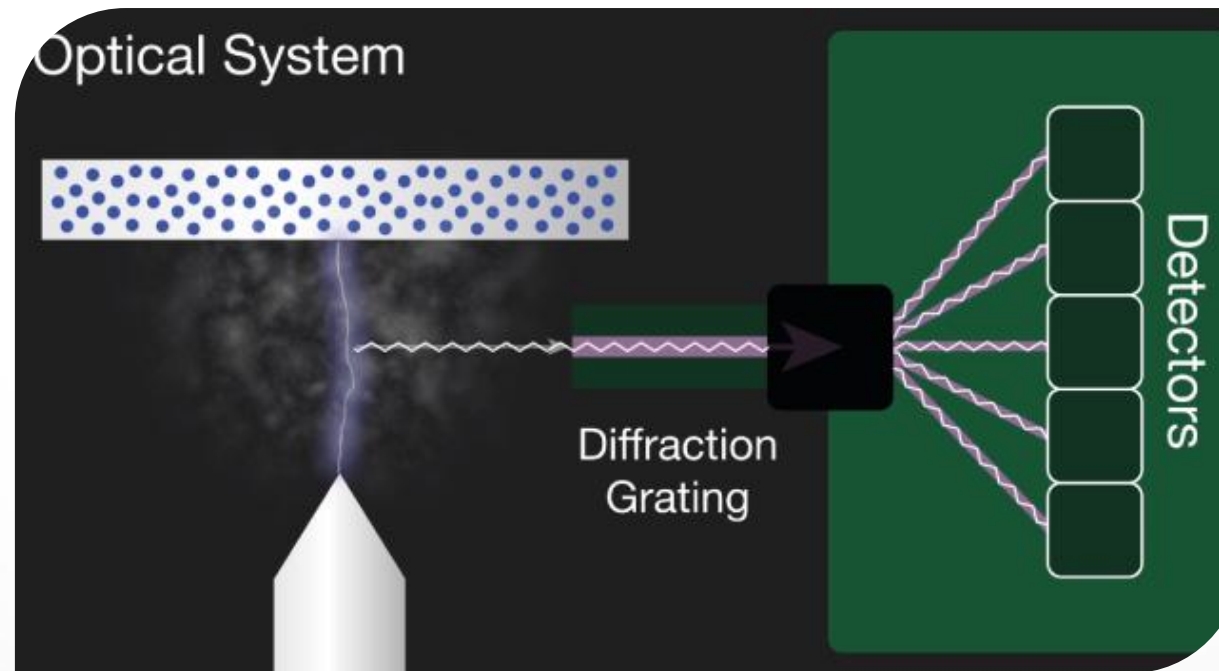
Electron Transition: Electrons from higher energy shells (like the L-shell or M-shell) fall to fill the vacancy created in the inner shell.



Detection and Analysis: The emitted X-rays are detected, and their energy is analyzed to identify and quantify the elements in the sample.

What is OES

- OES - Optical emission spectroscopy.





- Optical Emission Spectroscopy (OES), also known as atomic emission spectroscopy, is an analytical technique used to determine the elemental composition of a substance by analyzing the light emitted when it's excited, often by a spark or plasma.

Chemical Elements FOR XRF



PubChem

1 H Hydrogen Nonmetal																	2 He Helium Noble Gas															
3 Li Lithium Alkali Metal	4 Be Beryllium Alkaline Earth M...	Atomic Number										17 Cl Chlorine Halogen	Symbol					5 B Boron Metalloid	6 C Carbon Nonmetal	7 N Nitrogen Nonmetal	8 O Oxygen Nonmetal	9 F Fluorine Halogen	10 Ne Neon Noble Gas									
		Name		Chemical Group Block																												
11 Na Sodium Alkali Metal	12 Mg Magnesium Alkaline Earth M...																	13 Al Aluminum Post-Transition ...	14 Si Silicon Metalloid	15 P Phosphorus Nonmetal	16 S Sulfur Nonmetal	17 Cl Chlorine Halogen	18 Ar Argon Noble Gas									
19 K Potassium Alkali Metal	20 Ca Calcium Alkaline Earth M...	21 Sc Scandium Transition Metal	22 Ti Titanium Transition Metal	23 V Vanadium Transition Metal	24 Cr Chromium Transition Metal	25 Mn Manganese Transition Metal	26 Fe Iron Transition Metal	27 Co Cobalt Transition Metal	28 Ni Nickel Transition Metal	29 Cu Copper Transition Metal	30 Zn Zinc Transition Metal	31 Ga Gallium Post-Transition ...	32 Ge Germanium Metalloid	33 As Arsenic Metalloid	34 Se Selenium Nonmetal	35 Br Bromine Halogen	36 Kr Krypton Noble Gas															
37 Rb Rubidium Alkali Metal	38 Sr Strontium Alkaline Earth M...	39 Y Yttrium Transition Metal	40 Zr Zirconium Transition Metal	41 Nb Niobium Transition Metal	42 Mo Molybdenum Transition Metal	43 Tc Technetium Transition Metal	44 Ru Ruthenium Transition Metal	45 Rh Rhodium Transition Metal	46 Pd Palladium Transition Metal	47 Ag Silver Transition Metal	48 Cd Cadmium Transition Metal	49 In Indium Post-Transition ...	50 Sn Tin Post-Transition ...	51 Sb Antimony Metalloid	52 Te Tellurium Metalloid	53 I Iodine Halogen	54 Xe Xenon Noble Gas															
55 Cs Cesium Alkali Metal	56 Ba Barium Alkaline Earth M...																	72 Hf Hafnium Transition Metal	73 Ta Tantalum Transition Metal	74 W Tungsten Transition Metal	75 Re Rhenium Transition Metal	76 Os Osmium Transition Metal	77 Ir Iridium Transition Metal	78 Pt Platinum Transition Metal	79 Au Gold Transition Metal	80 Hg Mercury Transition Metal	81 Tl Thallium Post-Transition ...	82 Pb Lead Post-Transition ...	83 Bi Bismuth Post-Transition ...	84 Po Polonium Metalloid	85 At Astatine Halogen	86 Rn Radon Noble Gas
87 Fr Francium Alkali Metal	88 Ra Radium Alkaline Earth M...																	104 Rf Rutherfordium Transition Metal	105 Db Dubnium Transition Metal	106 Sg Seaborgium Transition Metal	107 Bh Bohrium Transition Metal	108 Hs Hassium Transition Metal	109 Mt Meitnerium Transition Metal	110 Ds Darmstadtium Transition Metal	111 Rg Roentgenium Transition Metal	112 Cn Copernicium Transition Metal	113 Nh Nihonium Post-Transition ...	114 Fl Flerovium Post-Transition ...	115 Mc Moscovium Post-Transition ...	116 Lv Livermorium Post-Transition ...	117 Ts Tennessine Halogen	118 Og Oganesson Noble Gas
																		57 La Lanthanum Lanthanide	58 Ce Cerium Lanthanide	59 Pr Praseodymium Lanthanide	60 Nd Neodymium Lanthanide	61 Pm Promethium Lanthanide	62 Sm Samarium Lanthanide	63 Eu Europium Lanthanide	64 Gd Gadolinium Lanthanide	65 Tb Terbium Lanthanide	66 Dy Dysprosium Lanthanide	67 Ho Holmium Lanthanide	68 Er Erbium Lanthanide	69 Tm Thulium Lanthanide	70 Yb Ytterbium Lanthanide	71 Lu Lutetium Lanthanide
																		89 Ac Actinium Actinide	90 Th Thorium Actinide	91 Pa Protactinium Actinide	92 U Uranium Actinide	93 Np Neptunium Actinide	94 Pu Plutonium Actinide	95 Am Americium Actinide	96 Cm Curium Actinide	97 Bk Berkelium Actinide	98 Cf Californium Actinide	99 Es Einsteinium Actinide	100 Fm Fermium Actinide	101 Md Mendelevium Actinide	102 No Nobelium Actinide	103 Lr Lawrencium Actinide

Chemical elements analyzed by XRF range from Sodium (11) to Uranium (92)

CRM



- CRMs are standards with precisely known values, used as benchmarks in analytical procedures
- *Calibrate XRF instruments:* Ensuring accurate measurements by comparing the instrument's readings to the known values of the CRM.
- *Validate analytical methods:* Confirming the reliability and accuracy of the XRF analysis process.



- *Check product quality:* Ensuring that the elemental composition of samples falls within acceptable limits.
- *Monitor instrument performance:* Providing a baseline for routine analysis and identifying potential issues.

ACCEPTANCE VALUE OF PMI



BASE MATERIALS

- PMI test results showing presence of characteristic elements upto 10% less than the minimum specified value in the material specification and upto 10% more than the maximum specified value in the material specification shall be acceptable.



WELD METAL

- The $\pm 12.5\%$ variation in chemical composition for characteristic elements is more commonly found in welding consumable specification or welding procedure qualifications, which are usually governed by section IX rather than section I.