Krishna Murti Chaturvedi
AM.EN.P2WNA22006
M.Tech WNA
IoT-Project-Assignment.

Namah Shivaya.

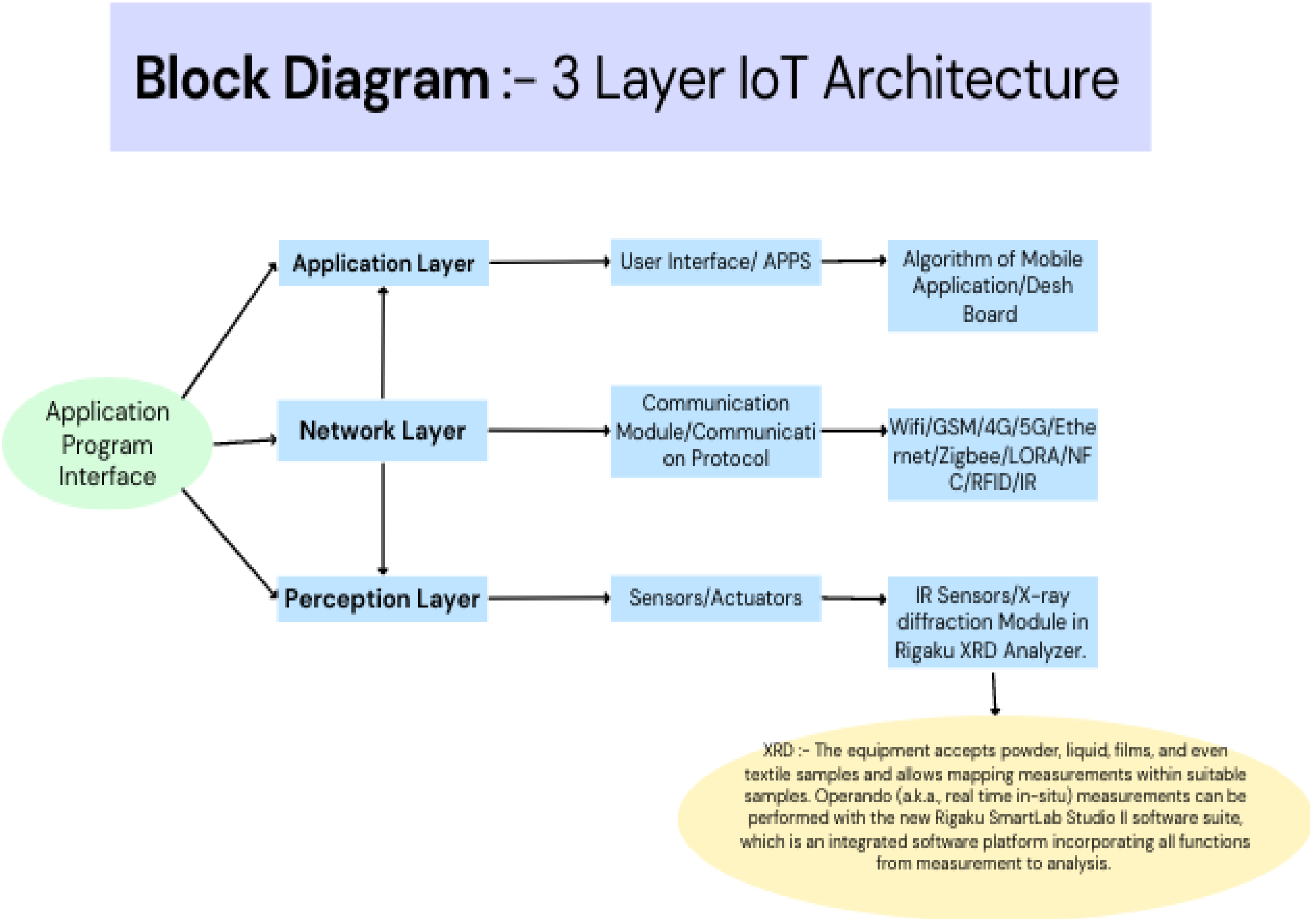
Create a 3 Layer IoT architecture:-

1. **Create a generic architecture and a 3-layer IoT architecture based on your term project.**

2. **Use google draw or similar software to create these architectures. Add this architecture in a document and describe the functionalities. Make sure you include the data flow between each module/block also.**

3. **Submit the files to your github repository on WNA organisation account and share the link when you submit the assignment.**

“Composition Identification System based on IoT System.”



IoT architecture typically includes three layers:

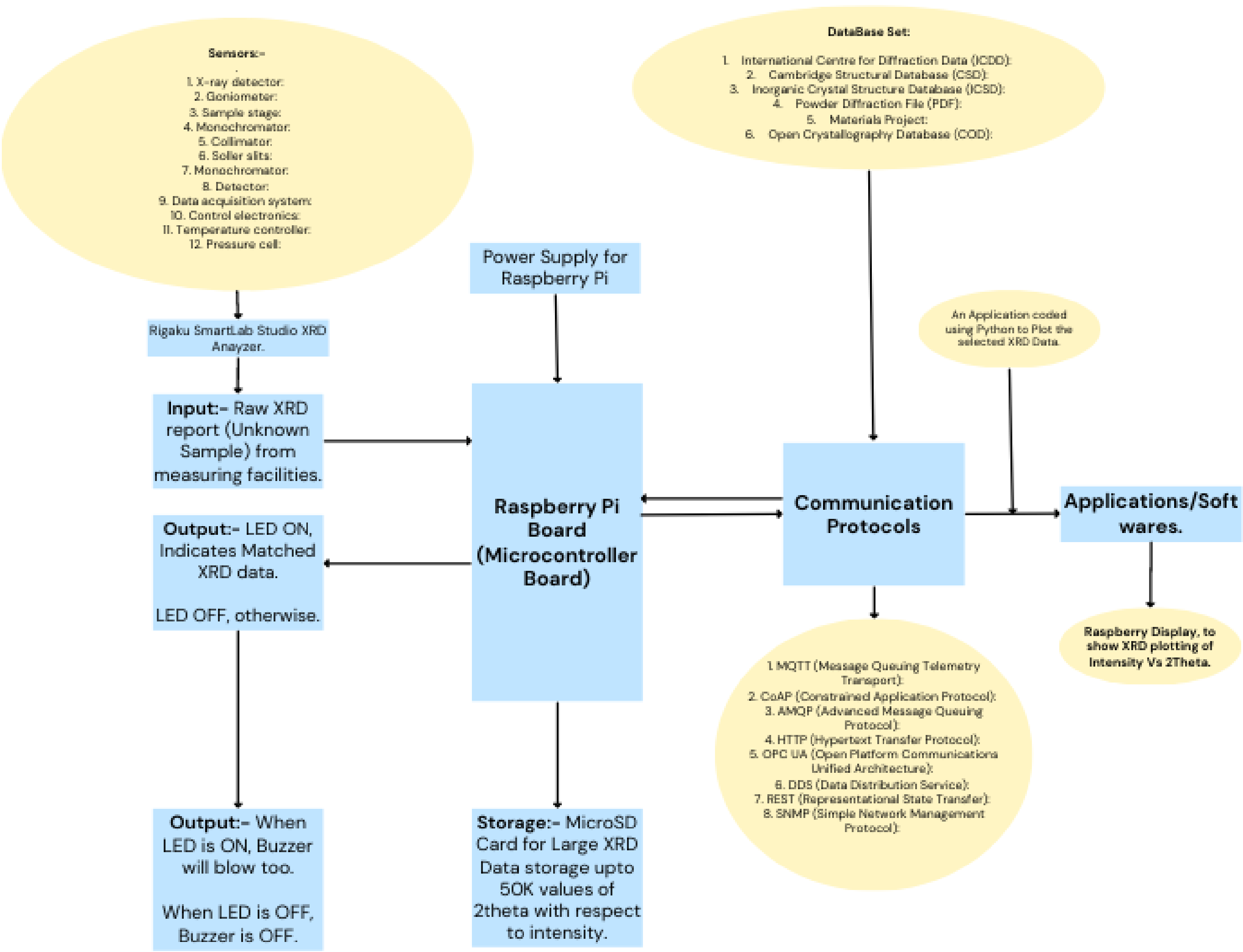
Perception Layer: This layer is also known as the sensing or input layer, and it consists of sensors, actuators, and other devices that collect and process data from the physical world. This layer interacts directly with the environment and captures data such as temperature, humidity, light, and motion.

Network Layer: This layer provides the connectivity required to transmit data between devices in the perception layer and the application layer. It includes protocols and technologies such as Wi-Fi, Bluetooth, and Zigbee, which enable communication between devices and facilitate data exchange.

Application Layer: This layer is responsible for processing and analyzing the data collected from the perception layer to derive insights and make decisions. It includes cloud computing, machine learning algorithms, and other technologies that enable the processing and analysis of large volumes of data generated by IoT devices.

This three-layer IoT architecture allows for efficient data collection, transmission, and analysis, which are essential for realizing the full potential of the Internet of Things.

Block Diagram :- Composition Identification System-CIS-IoT System



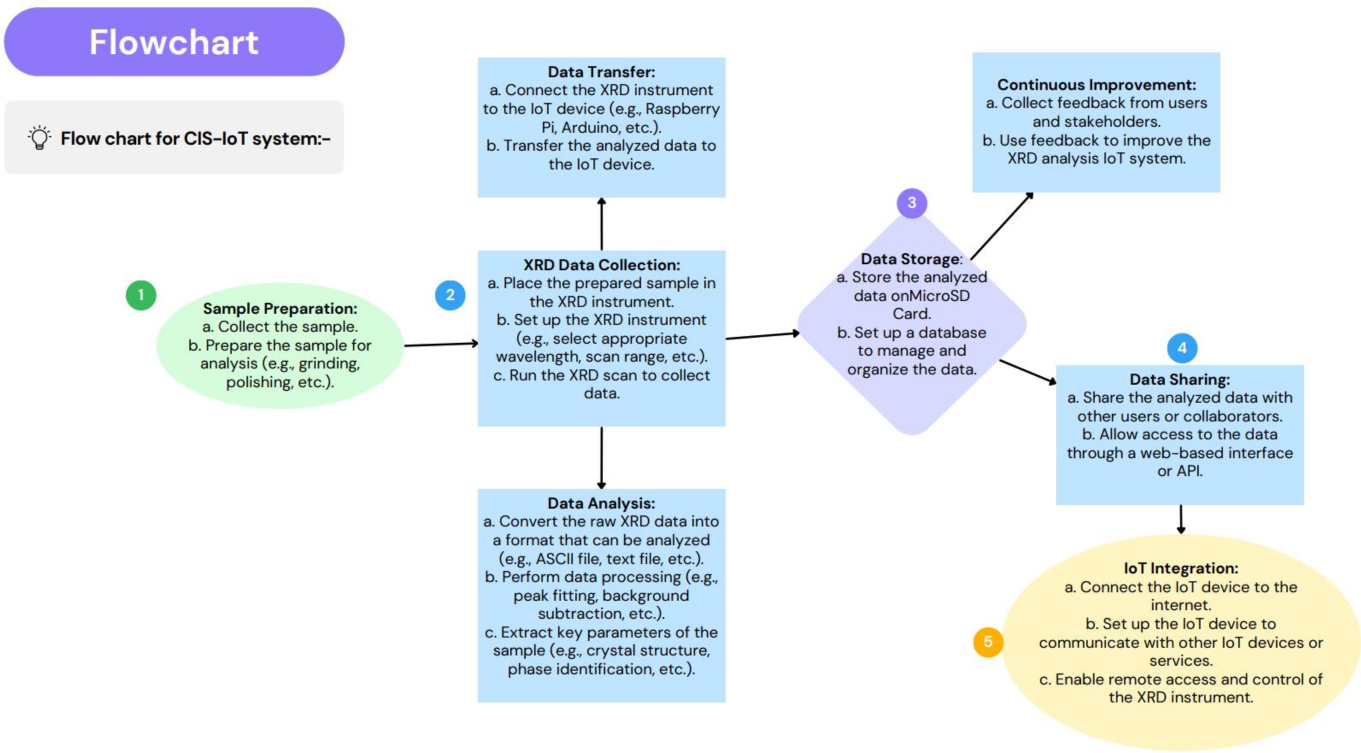
Introduction:

XRD stands for X-ray diffraction, and XRD analysis is a technique used to analyze the crystalline structure of materials. The XRD analysis technique involves the interaction of X-rays with the atoms in a crystal, which results in the scattering of the X-rays in specific directions, producing a diffraction pattern.

The diffraction pattern obtained from XRD analysis provides information about the arrangement of atoms in a crystal, as well as the size and shape of the crystal lattice. XRD analysis is widely used in materials science, geology, chemistry, and other fields to identify and characterize the crystal structure of various materials, including metals, ceramics, minerals, polymers, and pharmaceuticals.

XRD analysis involves the use of an X-ray diffractometer, which is a device that directs a beam of X-rays at a sample and measures the intensity of the scattered X-rays at different angles. The X-ray source used in XRD analysis is typically a copper or cobalt target, which produces X-rays with wavelengths in the range of 0.1 to 2 angstroms.

The diffraction pattern obtained from XRD analysis is typically analyzed using software that can identify the crystal structure of the material based on the positions and intensities of the diffraction peaks. The software can also be used to determine the lattice parameters of the crystal, which provide information about the spacing between atoms in the crystal lattice.



Some Popular XRD Dataset:-

XRD analysis relies heavily on databases and data sets to accurately identify the crystal structure of a material based on its diffraction pattern. There are several databases and data sets that are commonly used in XRD analysis, including:

1. **International Centre for Diffraction Data (ICDD):** The ICDD is one of the most widely used databases in XRD analysis. It contains a comprehensive collection of powder diffraction data, including over 400,000 unique diffraction patterns from inorganic materials, organic materials, and minerals.

2. **Cambridge Structural Database (CSD):** The CSD is a database of crystal structures that contains over one million entries, including organic and metal-organic compounds. It is used in XRD analysis to match a given diffraction pattern with known crystal structures.

3. **Inorganic Crystal Structure Database (ICSD):** The ICSD is a database of inorganic crystal structures that contains over 200,000 entries. It is used in XRD analysis to identify the crystal structure of a material based on its diffraction pattern.

4. **Powder Diffraction File (PDF):** The PDF is a collection of powder diffraction patterns that contains over 1 million entries. It is used in XRD analysis to match a given diffraction pattern with known patterns in the database.

5. **Materials Project:** The Materials Project is a database of computed materials properties that contains over 100,000 materials. It includes computed XRD patterns for many materials, which can be used in XRD analysis to help identify the crystal structure of a material.

6. **Open Crystallography Database (COD):** The COD is an open-access database of crystal structures that contains over 400,000 entries. It is used in XRD analysis to match a given diffraction pattern with known crystal structures.

In addition to these databases, many researchers also create their own data sets by collecting diffraction patterns from materials they have synthesized or analyzed. These data sets can be used in XRD analysis to identify the crystal structure of a new material or to refine the crystal structure of a known material.

Database matching procedure:-

X-ray diffraction (XRD) databases typically search for matching compositions by comparing the experimental XRD pattern of a sample to the XRD patterns of known crystalline materials stored in the database.

XRD patterns are essentially plots of the intensity of X-rays scattered at different angles by the atoms in a crystalline material. These patterns are characteristic of the crystal structure and composition of the material. By comparing the XRD pattern of an unknown sample to those in the database, it is possible to identify the crystal structure and composition of the sample.

To perform a search in an XRD database, the XRD pattern of the unknown sample is typically first uploaded or input into the database software. The database then searches for matching patterns from its stored library of XRD patterns using a variety of algorithms and search criteria, such as peak positions, peak intensities, and peak shapes. The software may also take into account other factors such as sample preparation, instrument settings, and environmental conditions.

Once a match is found, the database typically provides information about the crystal structure, composition, and properties of the identified material. It may also provide additional information such as references to published literature, images, and other related data.

Physicals behind XRD:-

XRD analysis is based on the physics of X-ray diffraction, which is a phenomenon that occurs when X-rays interact with the atoms in a crystal. When X-rays are incident on a crystal, they are scattered in different directions by the atoms in the crystal lattice. The scattered X-rays interfere with each other, producing a diffraction pattern that is characteristic of the crystal structure.

The diffraction pattern is produced because the X-rays interact with the electrons in the atoms in the crystal lattice. The electrons in the atoms are arranged in shells around the nucleus, and when X-rays are incident on the crystal, they cause the electrons to oscillate. This oscillation causes the electrons to emit secondary waves of radiation, which interfere with each other and with the incident X-rays, resulting in a diffraction pattern.

The diffraction pattern produced by XRD analysis contains information about the crystal structure of the material, including the size and shape of the crystal lattice, the spacing between atoms in the lattice, and the orientation of the crystal. By analyzing the diffraction pattern, XRD analysis can be used to identify the crystal structure of a material, as well as its degree of crystallinity and other properties.

In XRD analysis, the X-rays used are typically in the range of 0.1 to 2 angstroms, which corresponds to the size of the interatomic spacing in the crystal lattice. The diffraction pattern is produced when the angle of incidence of the X-rays is adjusted so that it corresponds to the angle at which the scattered X-rays interfere constructively, resulting in a diffraction peak. The position and intensity of the diffraction peaks can be used to determine the crystal structure of the material.

Overall, the physics behind XRD analysis is based on the interaction of X-rays with the atoms in a crystal lattice, and the resulting interference pattern that is produced by the scattered X-rays. This interference pattern contains information about the crystal structure of the material, which can be analyzed to determine its properties and behavior.

IoT protocols used for database processing:-

IoT (Internet of Things) devices use different protocols for communication with databases, depending on the application and specific requirements. Some of the most common IoT protocols used for database searching are:

1. **MQTT (Message Queuing Telemetry Transport):** A lightweight, publish-subscribe messaging protocol that is designed for use in constrained environments, such as IoT devices.
2. **CoAP (Constrained Application Protocol):** A lightweight protocol that is used for resource-constrained IoT devices, such as those with limited memory, processing power, and battery life.
3. **AMQP (Advanced Message Queuing Protocol):** A protocol that is designed for real-time communication and is used for IoT devices that require high levels of reliability and security.
4. **HTTP (Hypertext Transfer Protocol):** A protocol that is commonly used for communication between web applications and databases.
5. **OPC UA (Open Platform Communications Unified Architecture):** A protocol that is designed for industrial automation and is used for communication between IoT devices and industrial databases.
6. **DDS (Data Distribution Service):** A protocol that is designed for real-time data exchange and is used for IoT applications that require high levels of performance and scalability.
7. **REST (Representational State Transfer):** A protocol that is used for web-based applications and is commonly used for communication between IoT devices and databases.
8. **SNMP (Simple Network Management Protocol):** A protocol that is used for network management and is commonly used for communication between IoT devices and network databases.

Sensors used in XRD Analysis:-

XRD analysis involves the use of several sensing and sensor technologies to detect and measure the diffraction pattern produced by X-rays interacting with a crystal. The following are the most common sensing and sensors used in XRD analysis:

1. **X-ray detector:** X-ray detectors are used to detect the X-rays that are scattered by the crystal and to convert them into an electronic signal. The most commonly used detectors in XRD analysis are scintillation detectors, which use a scintillator material to produce light when X-rays interact with it. The light is then detected by a photomultiplier tube, which amplifies the signal and produces an output voltage proportional to the intensity of the X-rays.
2. **Goniometer: A** goniometer is used to accurately position the crystal and the X-ray detector at different angles relative to each other. This allows the diffraction pattern to be measured over a range of angles, which is necessary to accurately determine the crystal structure of the material.
3. **Sample stage**: The sample stage is used to hold and position the sample in the X-ray beam. The sample can be rotated and moved in different directions to adjust the angle of incidence of the X-rays and to ensure that the crystal is oriented correctly.
4. **Monochromator:** A monochromator is used to select a single wavelength of X-rays from a polychromatic X-ray source. This is necessary to ensure that the diffraction pattern is produced at a consistent wavelength and to improve the accuracy of the analysis.
5. **Collimator:** A collimator is used to focus the X-ray beam onto the sample and to reduce background radiation. This is necessary to improve the signal-to-noise ratio and to ensure that the diffraction pattern is accurately measured.
6. **Soller slits:** Soller slits are used to reduce the divergence of the X-ray beam and to improve the resolution of the diffraction pattern.
7. **Monochromator:** The monochromator filters the X-rays emitted from the X-ray source to produce a monochromatic beam of X-rays. This beam is then directed towards the sample.
8. **Detector:** The detector measures the intensity of the X-rays that are diffracted by the sample. Common types of detectors include scintillation counters, proportional counters, and solid-state detectors.
9. **Data acquisition system:** The data acquisition system collects the signals from the detector and converts them into a digital format that can be analyzed by a computer.
10. **Control electronics:** The control electronics regulate the X-ray source and the other components of the XRD analyzer.

11. **Temperature controller**: Some XRD analyzers have a temperature controller, which allows for the analysis of samples at different temperatures.
12. **Pressure cell:** Some XRD analyzers also have a pressure cell, which allows for the analysis of samples at different pressures.

Overall, XRD analysis relies on a combination of sensing and sensor technologies to accurately measure the diffraction pattern produced by X-rays interacting with a crystal. The most important sensors are the X-ray detector, which detects the scattered X-rays and converts them into an electronic signal, and the goniometer, which accurately positions the crystal and the detector at different angles to produce a complete diffraction pattern.

Factors affecting the XRD analysis:-

There are several factors that can affect the X-ray diffraction (XRD) analysis of a material, including:

1. **Sample preparation:** The preparation of the sample can have a significant impact on the XRD analysis. Factors such as the particle size, homogeneity, and orientation of the sample can all affect the XRD pattern. Careful preparation techniques are therefore required to obtain accurate and reproducible results.
2. **Instrumentation:** The type and quality of the XRD instrument can also affect the analysis. Factors such as the resolution, sensitivity, and calibration of the instrument can all impact the accuracy and precision of the XRD measurements.
3. **X-ray source:** The type and characteristics of the X-ray source can affect the XRD analysis. The wavelength and intensity of the X-rays, as well as the angle of incidence and the geometry of the X-ray beam, can all impact the XRD pattern.
4. **Crystal structure:** The crystal structure of the material being analyzed can affect the XRD pattern. Different crystal structures can produce different XRD patterns, so it is important to have accurate information about the crystal structure of the material in order to correctly identify it.

5. **Temperature and pressure:** The temperature and pressure at which the XRD analysis is performed can also affect the results. Changes in temperature and pressure can cause the crystal structure of the material to change, which can alter the XRD pattern.
6. **Background noise:** Finally, various sources of background noise, such as scattering from the sample holder or the instrument components, can also affect the XRD analysis. Techniques such as background subtraction and filtering are often used to minimize the impact of background noise on the XRD pattern.

XRD analyser manufacturers:-

X-ray diffraction (XRD) analyzers are used to determine the crystal structure of materials. There are several famous companies that manufacture XRD analyzers, including:

1. **Bruker:** Bruker is a leading provider of scientific instruments, including XRD analyzers. Their products include the D8 ADVANCE X-ray diffractometer, the D2 PHASER benchtop XRD system, and the S8 TIGER X-ray fluorescence spectrometer.
2. **Rigaku:** Rigaku is another major player in the XRD analyzer market. They offer a range of products, including the SmartLab X-ray diffractometer, the MiniFlex benchtop XRD system, and the Supermini200 benchtop X-ray fluorescence spectrometer.
3. **PANalytical:** PANalytical, now part of Malvern Panalytical, is a leading provider of XRD and X-ray fluorescence (XRF) analyzers. Their products include the Empyrean X-ray diffractometer, the CubiX^3 powder X-ray diffractometer, and the Epsilon 4 benchtop XRF spectrometer.
4. **Thermo Fisher Scientific:** Thermo Fisher Scientific offers a range of XRD analyzers, including the ARL EQUINOX 1000 X-ray diffractometer, the ARL EQUINOX 3000 X-ray diffractometer, and the ARL EQUINOX 5000 X-ray diffractometer.
5. **Shimadzu:** Shimadzu is a Japanese company that produces a wide range of analytical instruments, including XRD analyzers. Their products include the XRD-6000 X-ray diffractometer and the XRF-1800 X-ray fluorescence spectrometer.

6. **JEOL:** JEOL is a Japanese company that produces a range of scientific instruments, including XRD analyzers. Their products include the JDX-3530 X-ray diffractometer and the JXA-iHP200F X-ray fluorescence spectrometer.