

# The XRF Analyzer

Skyray INSTRUMENT



XRF  
spectromete

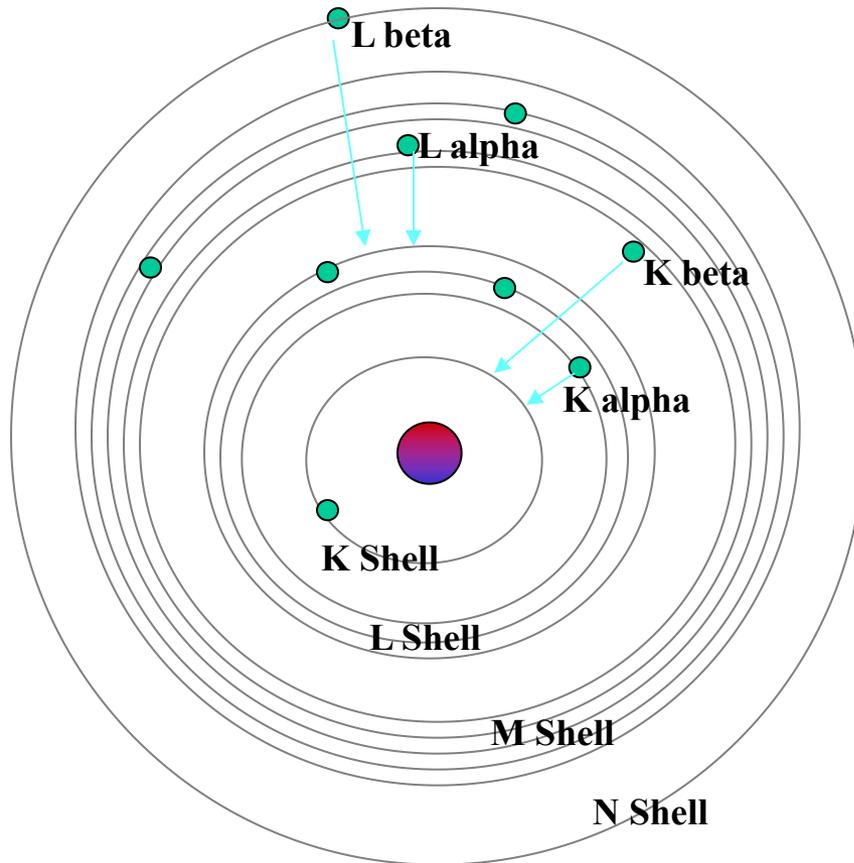


Handheld, mobile, desktop & laboratory EDXRF spectrometers

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- ❖ The applications

# Basic principle

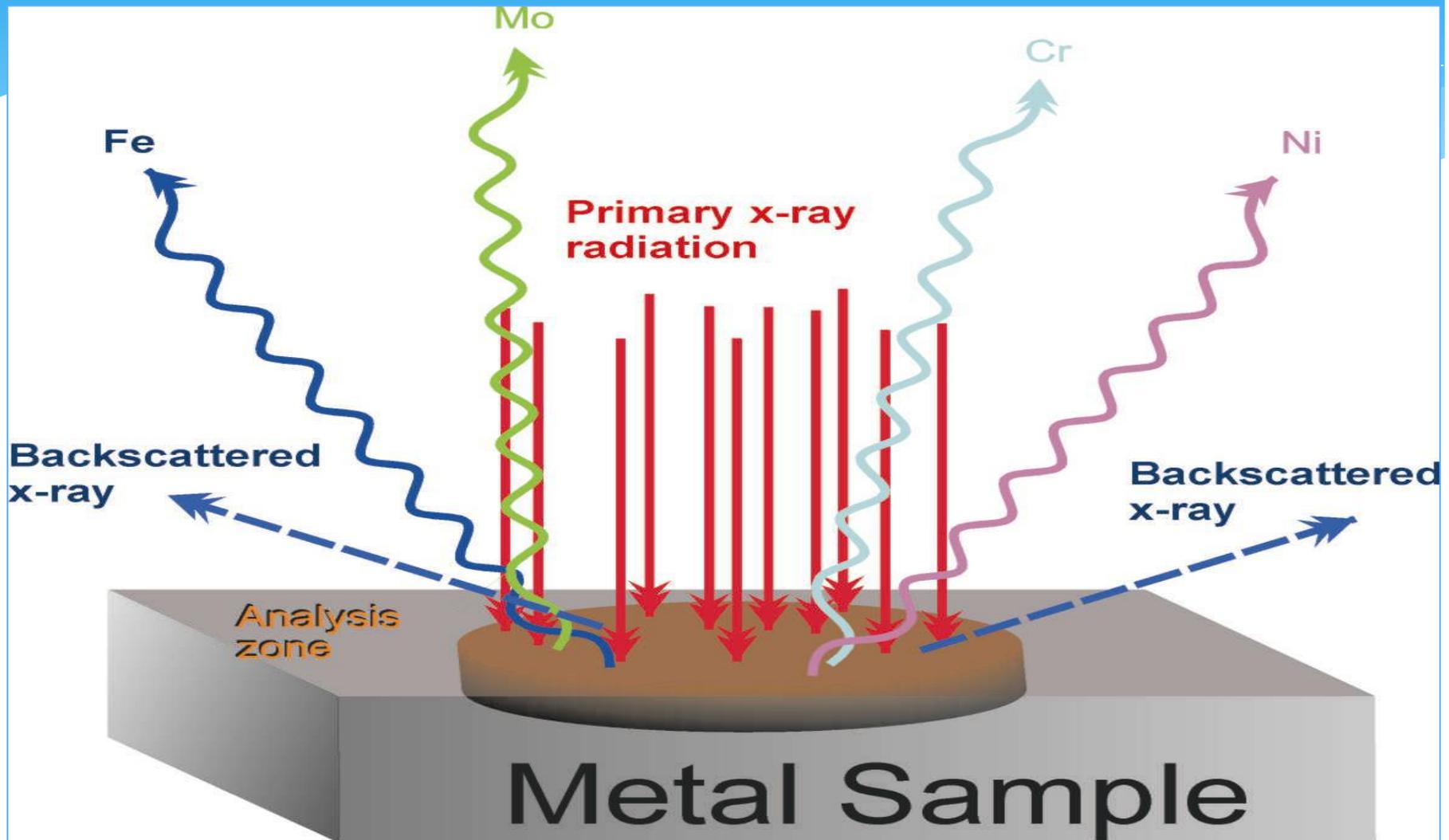


- ❖ **K - alpha lines:** L shell e- transition to fill vacancy in K shell. Most frequent transition, hence most intense peak.
- ❖ **K - beta lines:** M shell e- transitions to fill vacancy in K shell.
- ❖ **L - alpha lines:** M shell e- transition to fill vacancy in L shell.
- ❖ **L - beta lines:** N shell e- transition to fill vacancy in L shell.

# Basic principle

- \* XRF means for X-Ray Fluorescence, a process whereby electrons are displaced from their atomic orbital positions, releasing a burst of energy that is characteristic of a specific element. This release of energy is then registered by the detector in then XRF instrument, which in turn categorizes the energies by element.

By counting the number of characteristic x-rays, we can determine the concentration of each element



# Basic instrument diagram





# The features of XRF

## ❖ Advantages

- ❖ fast results
- ❖ completely nondestructive
- ❖ qualitative and/or quantitative multi-element analysis
- ❖ little or no sample prep
- ❖ can be used for many different sample types sizes and shapes - solids, powders, liquids, turnings, etc.
- ❖ robust calibration covering range from detection limit to 100%
- ❖ Wide analytical range. From Sodium(11) to Uranium(92) can be measured in one unit.
- ❖ Wide content range. From 2ppm to 99.99%

## ❖ Limitations

- ❖ limited capability for lighter elements (below atomic number 19)
- ❖ minimum detection limits in ppm range

# The applications

Typical uses include the analysis of oils and fuel, plastic, rubber and textiles, pharmaceutical products, foodstuffs, cosmetics and body care products, fertilizers, minerals, ores, rocks, sands, slags, cements, heat-resistant materials, glass, ceramics, wafers; the determination of coatings on paper, film, polyester, and metals; XRF RoHS testing, positive material identification, the sorting of metal alloys, glass and plastic according to their constituent materials; and the monitoring of solid waste, effluent, cleaning fluids, pools and filters.

- \* -**Alloy/scrap** metal analysis. Extinguish different type of stainless steel of 304/316/321 by analyzing the metal content in the sample within 3 seconds.
- \* - **Jewelry/ precious metal**. Identify the karat of the gold (9k, 14k, 18k, 22k etc.) sample in one second
- \* - **RoHs compliance (Cr, Cd, Pb, Hg, Br, As, Se, Sb, Bi)**. Fast screen the 8 heavy metals restricted by law
- \* - **Mineral and mining**.
- \* - **Cement**
- \* -**Soil heavy metal pollution measurement**.
- \* -**Sulfur in oil/lubricant** from ppm to percent level.
- \* -**Coating Thickness and chemical content analysis**
- \* - **Heavy metals in air+ PM10+PM2.5**

# Alloy application

- \* All common Fe, Ni, Co, Ti, and Cu based alloys/elements are included in our factory calibration/library
  - >over 300 alloy grades currently installed
  - >maximum of 1000 may be installed
  - >users may add, delete, rename, or modify the our alloy library
  - >users may generate their own custom library



# Fast results with excellent accuracy

- \* Rapid grade identification results
  - \* Positive material identification
  - \* ~3 seconds with "good" chemistry
  - \* Scrap metal sorting
  - \* Metal alloys

SS 316

Cr Lo	16.00	Cr Hi	18.00
Mo Lo	2.00	Mo Hi	3.00
Ni Lo	10.00	Ni Hi	14.00
Mn Lo	0.00	Mn Hi	2.00
Fe Lo	63.00	Fe Hi	72.00



# Jewelry/Gold applications



XRF for Non-destructive precious metals analysis

- \* **Jewelers**
- \* **Recyclers**
- \* **Refiners**
- \* **QC Department**
- \* **Cash-for-gold**



- \* Fast Karat Identification. From 4K,7k, 9k, 14k, 18k, 20k 22k to 24k sorted out in 20 seconds. Below shows the FP calibrations of Au and Ag.
- \* Most popular tool nowadays for precious metal business.



# RoHS and WEEE applications

\* European Parliament and Council

**ELV**

**End of Life Vehicles**

Directive 2000/53/EC



**WEEE**

**Waste Electrical and Electronic Equipment Directive**

2002/96/EC

**RoHS**

**Restriction of Hazardous Substances**

Directive 2002/95/EC

# EU regulations

Directive	Description
EC Directive 94/62/EC, Article 11	the sum of Cr+6, Hg, Pb, and Cd in packaging materials may not be more than 100 mg/kg (ppm)
EC Directive 91/338/EC	100 [mg/kg] as the maximum allowable concentration of cadmium in consumer goods.
EC Directive 2002/95/EC of 27 January 2003	<b>Restriction of the use of certain Hazardous Substances</b> in electrical and electronic equipment (The RoHS Directive). <i>Targets maximum levels of Cr+6, Hg, Cd, Pb, PBB and PBDE (all at 0.1% except for Cd for which it is 0.01%)</i>
EC Directive 2002/96/EC of 27 January 2003	<b>Waste Electrical and Electronic Equipment</b> (The WEEE Directive). <i>Targets responsible recycling of electronic equipment</i>
EC Directive 2000/53/EC of 18 September 2000	<b>End-of-Life Vehicles (ELV)</b> <i>Targets responsible recycling of automotive waste</i>

# RoHS/WEEE Directives

- Reduce and eventually eliminate the use of prohibited substances at the source (RoHS)
  - *Maximum permissible levels in a homogeneous material will be as follows:*

• <b>Cadmium (Cd)</b>	<b>100 ppm</b>
• <b>Mercury (Hg)</b>	<b>1000 ppm</b>
• <b>Lead (Pb)</b>	<b>1000 ppm</b>
• <b>Hexavalentchromium (Cr(VI))</b>	<b>1000 ppm</b>
• <b>PolybrominatedBiphenyls</b>	<b>1000 ppm</b>
• <b>PolybrominatedDiphenylsEther</b>	<b>1000 ppm</b>
- Recycle as much of the product as possible after its useful life, in order to minimize the issues of disposal (WEEE).

# The Advantages of XRF for RoHs application

- \* Non-destructive. No sample limitations. Powder, solid and liquid can all be measured
- \* Optimum first line screening at incoming/QA inspection
- \* Multiple elements simultaneously for all banned substances
- \* Fast, “on the spot ”results Little to no sample preparation
- \* Cost effective way of obtaining “due diligence” data



# Mineral and soil application



**Exploration/prospecting:**  
Standard Bulk



**Exploration Drilling:**  
Standard Bulk  
and Industrial Bulk



**Ore Grade Control:**  
Industrial Bulk

**Environmental:**  
Standard Bulk  
and Industrial Bulk



**Processing:**  
Industrial Bulk



connect  
● 10 sec  
result: N



**\* Soil MODE [ppm]**  
**[formally known as Standard Bulk]**

**\* Ba, Sb, Sn, Cd, Ag, Pd, Mo, Zr, Sr, U, Rb, Th, Pb, Se, As, Tl, Pt, Au, Hg, Zn, Cu, Ni, Co, Fe, Mn, Cr, V, Ti, Sc, Ca, K Cl, S, P**

**\* MINING MODE [%]**  
**[formally know as industrial bulk]**

**Ba, Sn, Cd, Pd, Ag, Mo, Nb, Zr, Bi, Pb, As, Re, W, Ta, Hf, Zn, Cu, Ni, Co, Fe, Mn, Cr, V, Ti, Ca, Cl, K, S, Bal.**

# Typical application field

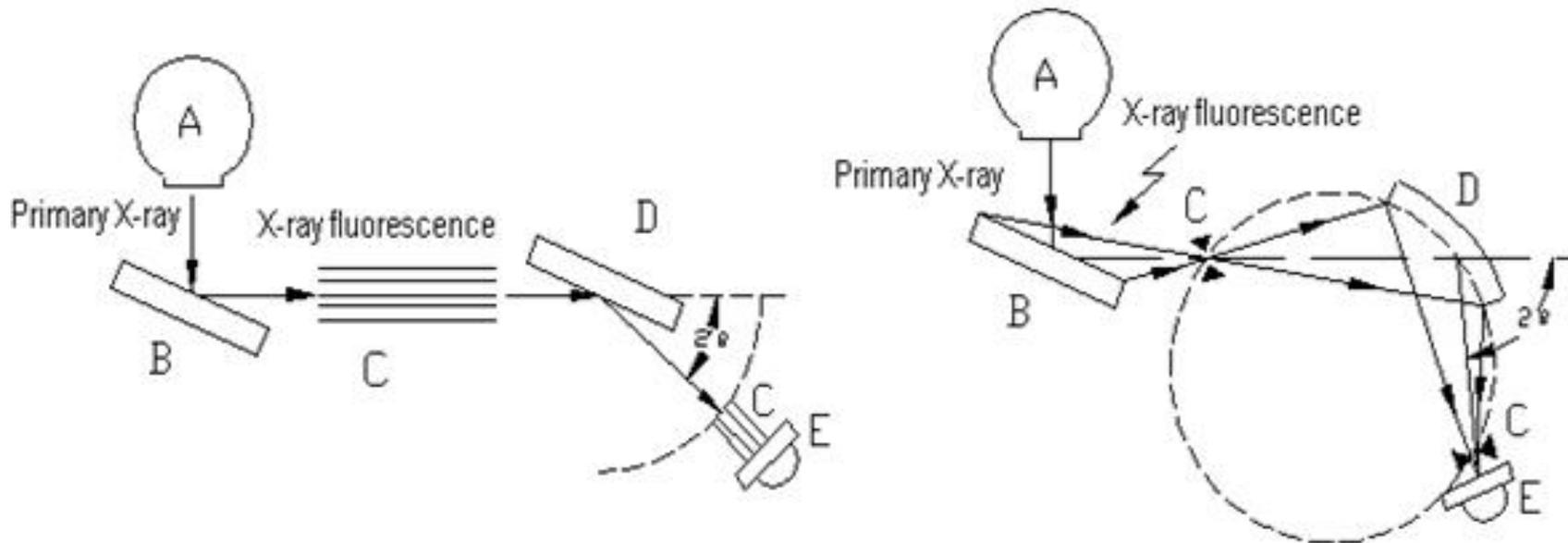
- \* Base-line soil surveys
- \* Acid-mine drainage
- \* Waste effluent monitoring
- \* Dust monitoring
- \* Derelict mine investigations
- \* Contaminated land assessment
- \* Site remediation and validation



- \* Lead/Zinc/Copper – exploration/mining/processing
- \* Nickel laterite and sulphide – exploration/mining/processing
- \* Minerals sands – exploration/mining/processing
- \* Uranium and Thorium - exploration/mining/processing
- \* Pathfinders for precious metals – exploration
- \* Iron ore, bauxite and coal exploration/mining/processing
- \* Silver and rare earth's exploration/mining/processing

# Cement Applications

- \* WDX200 X-ray Fluorescence Spectrometers works on the principle of wavelength dispersion technique, where CHARACTERISTIC X-rays of the interest element are separated and measured quantitatively according to its wavelength. Main application topics include as below
- \* Quantitative Analysis of Dolomite and Limestone by Pressed Powder Method with WDX200
- \* Cement Analysis by the Pressed Powder Method ASTM C114 – 1045
- \* Major oxides in finished cement
- \* Cement Raw Meal Analysis by the Pressed Powder Method



\* Modern Portland cement is made by mixing substances containing lime, silica, alumina, and iron oxide and then heating the mixture until it almost fuses. During the heating process dicalcium and tricalcium silicate, tricalcium aluminate, and a solid solution containing iron are formed. X-ray fluorescence (XRF), a standard technique across the cement industry, is used to determine metal-oxide concentrations and oxide stoichiometry.

- \* Analysis of elements from Be to U
- \* 200 watts end-window X-ray tube
- \* Up to 10 fixed channels
- \* Background corrections for fixed channels
- \* Log curved crystals and optimized optical path
- \* Compact design
- \* Multi-window, multi-function  
fundamental parameters (FP) software



# Coating Thickness Application

- \* Measurement of thickness of the metal coating on the surface of the sample
- \* Non-destructive analysis the chemical content of the coating layer (less than 5 layers)

Penetration depth		
Coating	Base	Thickness (μm)
Al	Cu	0-100.0
Cd	Fe	0-60.0
Cu	Al	0-30.0
Cu	Fe	0-30.0
Cu	Plastic	0-30.0
Au	Ceramic	0-8.0
Au	Cu/Ni	0-8.0
Pb	Cu/Ni	0-15.0
Ni	Al	0-20.0
Ni	Ceramic	0-20.0
Ni	Cu	0-20.0
Ni	Fe	0-20.0
Pd	Ni	0-40.0
Pd-Ni	Ni	0-20.0
Pt	Ti	0-8.0
Rh	Cu/Ni	0-50.0

# Coating thickness measurement and materials analysis to improve process and quality control with X-ray fluorescence (XRF)

- \* Ease of use
- \* Analysis in seconds
- \* Accurate analysis of single and multiple layers for quality assurance and process control
- \* Analysis of metal ion content for optimum plating bath control
- \* Non-destructive measurement with X-ray fluorescence
- \* Best price-performance ratio in the market
- \* Optional: XYZ table
- \* Industries: electronics, jewellery, metalworking

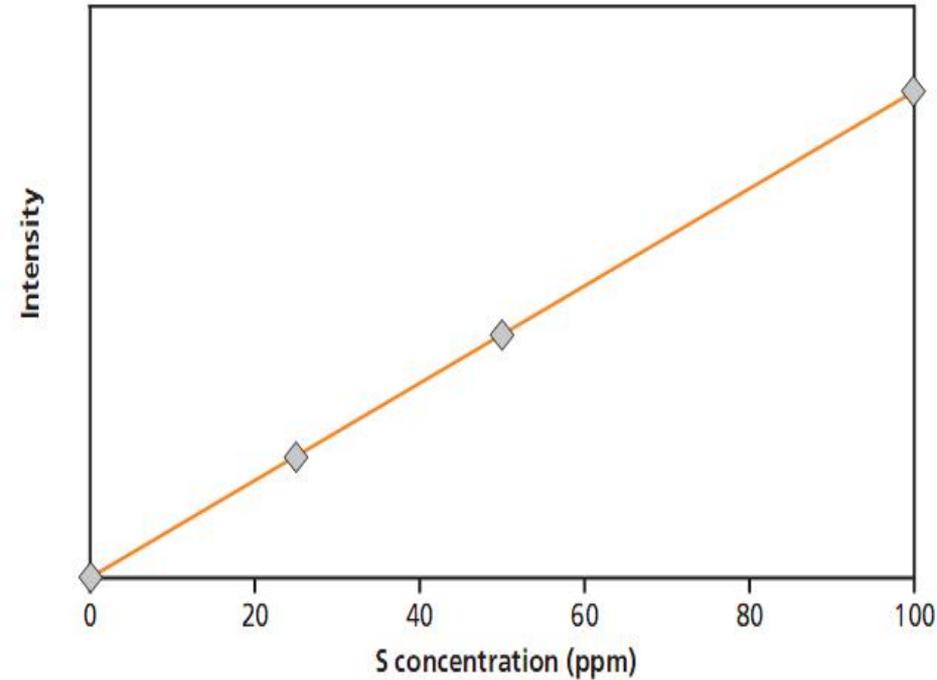
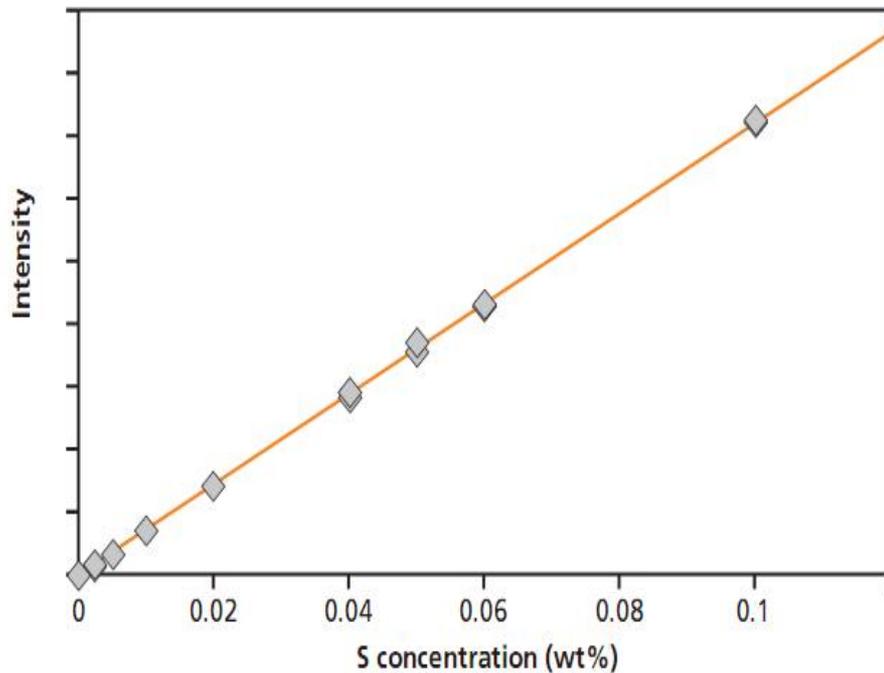


# Sulfur in oil Application

- \* Petroleum/Petrochem - Measure factors such as the concentration of elements in lubricating oil, sulfur in oils and fuels and the monitoring of recycled waste oil. Conforms to ASTM D4294, ISO20847, ISO8754 and IP336



# Sulfur analysis from PPM to Percent level in minutes



# Heavy metals in air+ PM10+PM2.5

- \* EHM-X100 can continuously measure and analysis a variety of heavy metal content and pollution particle size in atmospheric, and have the following applications:
- \* Air quality monitoring(PM2.5, particle size<2.5 micrometers. PM10, particle size<10 micrometers.
- \* Atmosphere particulates characteris
- \* Atmospheric background measuring
- \* Environmental assessment, licensing
- \* Pollution sources positioning, tracing
- \* Pollution forecast and early warning



Main Monitoring elements	Pb (lead), Cu (copper), Cd (cadmium), Hg (mercury), As (arsenic), Cr (chromium), Zn (zinc), Ni (Nickel), Ba (barium), Fe (iron), Ag (silver), Se (selenium), Br (bromine), Te (tellurium), Sb (antimony), Sn (tin), Ti (titanium), Co (cobalt), Mn (manganese), Pd (palladium), Tl (thallium), Sc (scandium), Mo (molybdenum), V (vanadium), Cs (cesium), Ga (gallium), Ca (calcium), K (potassium), Sr (strontium), Cl (chlorine), etc. (other elements can be expanded according to user needs)
Standards	U.S. EPA IO-3.3 standard method "X-ray fluorescence spectrometry detection of heavy metals in ambient particulate matter."
Measuring range	(0 ~ 100) $\mu\text{g}/\text{m}^3$
Detection limits	Minimum of $\text{pg}/\text{m}^3$

# XRF Air monitor system





Thanks