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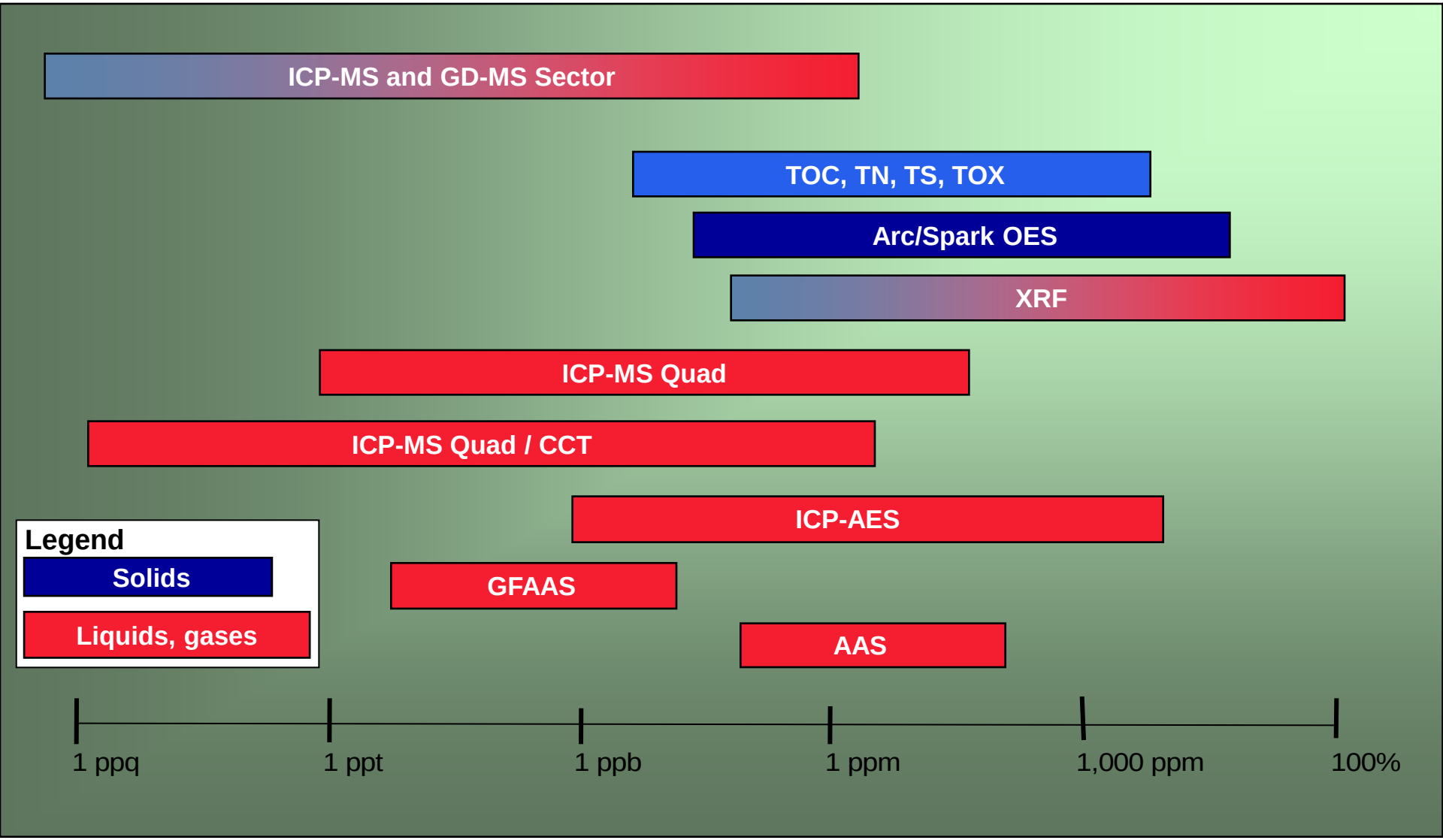
Thermo Fisher Scientific
OES and XRF/XRD product range

Sofia 2017

ACM2 Anniversary

Peter Bellant

Elemental Spectroscopy - Detection Limits and Dynamic Range



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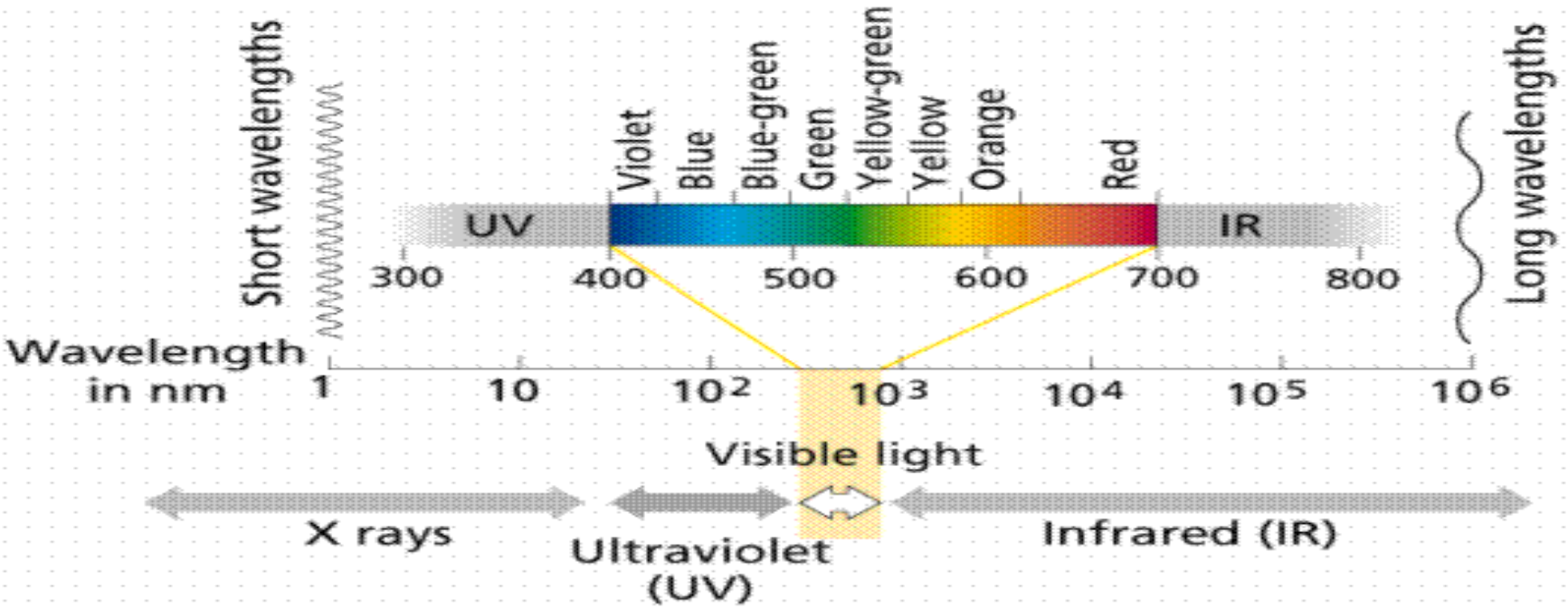
Arc/Spark Optical Emission Spectrometry

- In Optical Emission Spectrometry
  - We observe low energy electronic transitions
    - Typically several eV (1 eV ≅ 23 Kcal mol^{-1})
  - From VUV to NIR (100 - 900nm)

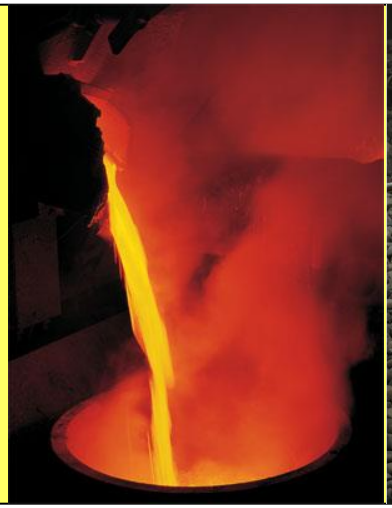


Why using Arc/Spark OES?

- Extremely fast and simple analysis of conducting solids
- Can analyze simultaneously > 40 elements from trace (ppm) to major (%) levels in <1 minute
  - ppm or sub-ppm limits of detections
  - Can analyze P, S, C, N, O at low levels
- Sample preparation is fast and simple
- Accurate, precise, stable, reliable
- Cheap analysis: low costs of ownership and maintenance
- High instrument availability
- Long life and robustness
- Well established (exists since 1934)

Use of Spark-OES

- Users of OES
  - Primary metals producers
  - Foundries
  - Metals processors
  - Metals recyclers
  - Service laboratories
  - Universities, research centers

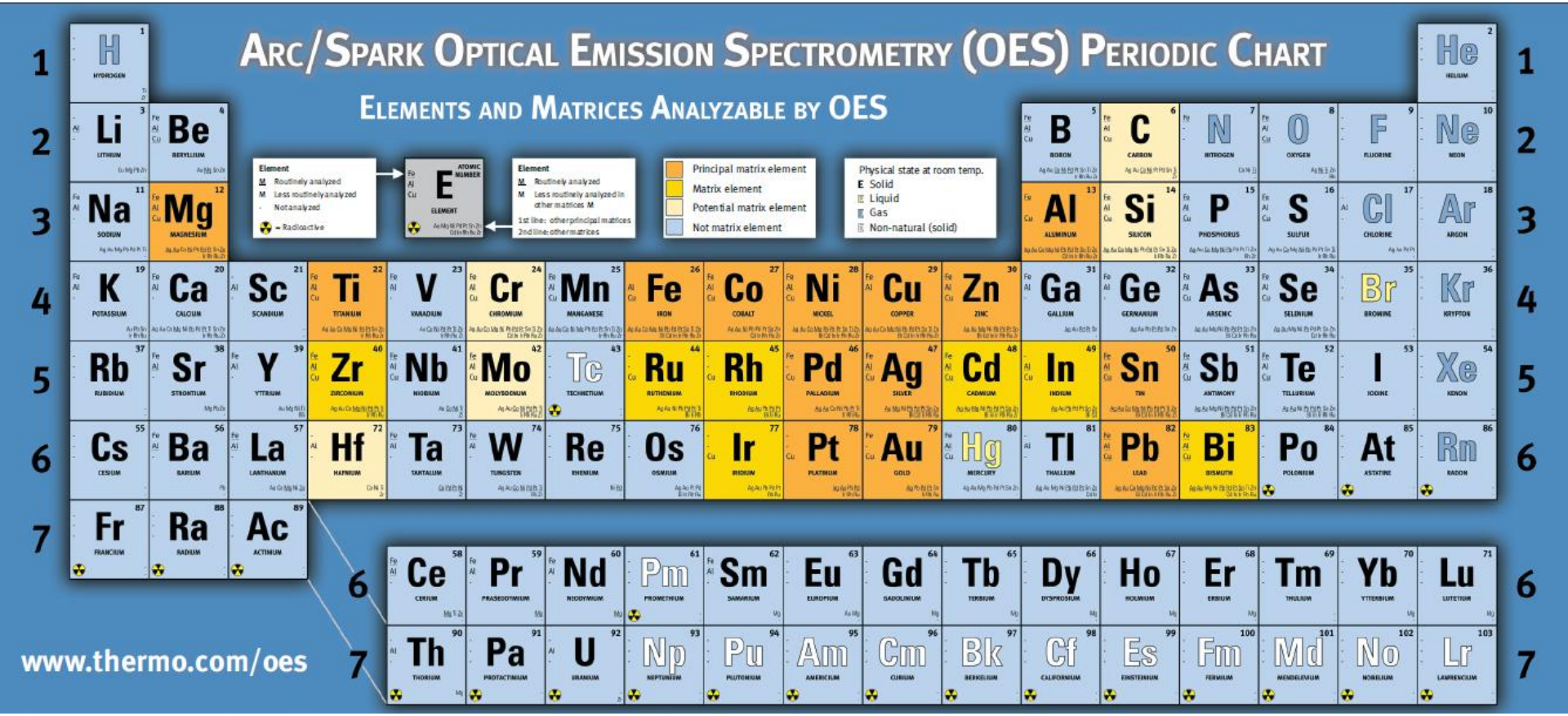


- OES instruments main uses
  - Process control
  - Final product quality control
  - Research
  - Certificate of analysis
  - Incoming materials control
  - Metal sorting

- Prerequisites for Spark-OES analysis
  - Solid conductive sample
  - Representative sample (sample taking)
  - Clean and flat sample surface (sample preparation)
  - Reference materials for calibration (CRM and RM)
  - Setting-up samples (SUS) for drift correction (to maintain accuracy)

Applications of Optical Emission Spectrometry

Elements and matrices analyzable by OES



14 routinely analyzed matrices

7 special matrices

5 potential matrices

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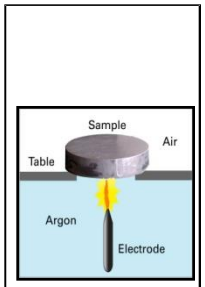
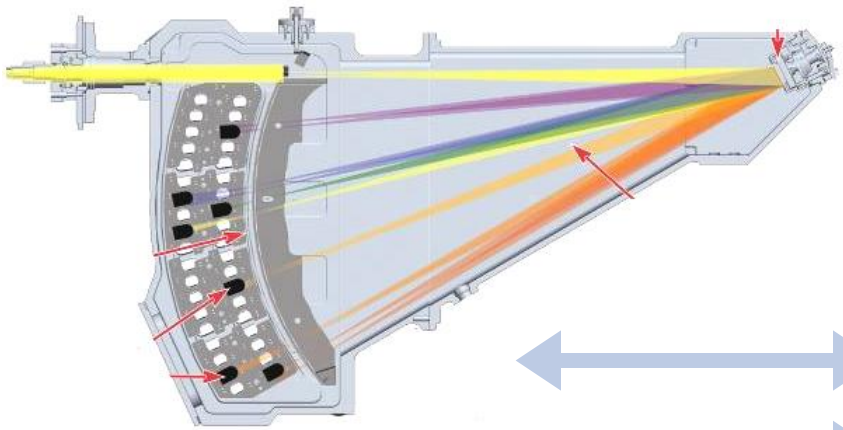
Spark-OES instrument operational diagram



Spark source & stand

Optics and detection



Electronics

Computer

(1) Preparation

(2) Ablation, excitation & light emission

(3) Light separation

(4) Light detection

(4) Signal acquisition

(Instrument control)

(5) Data processing

(Instrument control)

(1) PREPARATION → (2) EXCITATION & LIGHT EMISSION; (3) LIGHT SEPARATION; (4) LIGHT DETECTION & ACQUISITION → (5) DATA PROCESSING

ARL 3460

Mid-range to high-end PMT-based instrument

- The market reference
  - > 6’000 units sold since launch
- Mono- and multi-base
- Up to 60 channels in standard
- Standard Hirep source
- Conventional acquisition electronics
- Key differentiators
  - Reputation, large installed base
  - Overall performance, including stability
  - Reliability, robustness, lifetime
  - Quality of the calibration
  - OXSAS analytical software with SPC, Total Materia (Key to Metals) included, measurement uncertainty, Total Materia (Key to Metals) option, etc.

ARL 4460

Ultimate performance PMT instrument

- For many OES users, the best instrument on the market
- >2’300 units sold – a real success!
- Best sensitivity, speed of analysis, precision, accuracy on the market
- Digital technologies
  - Excitation with Current Controlled Source (CCS)
  - Acquisition with Time Resolved Spectroscopy (TRS)
- Inclusions analysis with the Spark-DAT option
  - Probably the fastest method for inclusion analysis
  - Can be used to control inclusions during production

ARL iSpark 8860 – Experience and performance

- Typical high-performance single matrix PMT instrument
  - Customized up to 80 PMTs
  - Typically for demanding steel plants, pure metals producers, companies that need best possible analysis of all the elements at trace level

- Some benefits
  - High level ultra-pure metal and trace element analysis
  - High analysis speed
  - Advanced signal acquisition and processing methods for all the channels
  - Highly reliable, high throughput automated analysis
  - Advanced ultra-fast inclusion analysis options available
  - Easy and fast stand maintenance for increased instrument availability
  - Synoptic tool for fast visual trouble-shooting
  - Significant argon savings

ARL iSPARK 8860
OES Metals Analyzer

ARL easySpark – Technical Highlights

- Innovative high safety open stand
- Multi grating / CCD spectrograph allowing continuous and wide elemental coverage including UV elements like Nitrogen
- Compact “intelliSource” CCS Source
- Robust, stable and low-frequency, easy maintenance stand
- Optimized argon stream design for improved analysis performances on difficult samples
- EasyOXSAS software with user-friendly interface matching all metal producers needs

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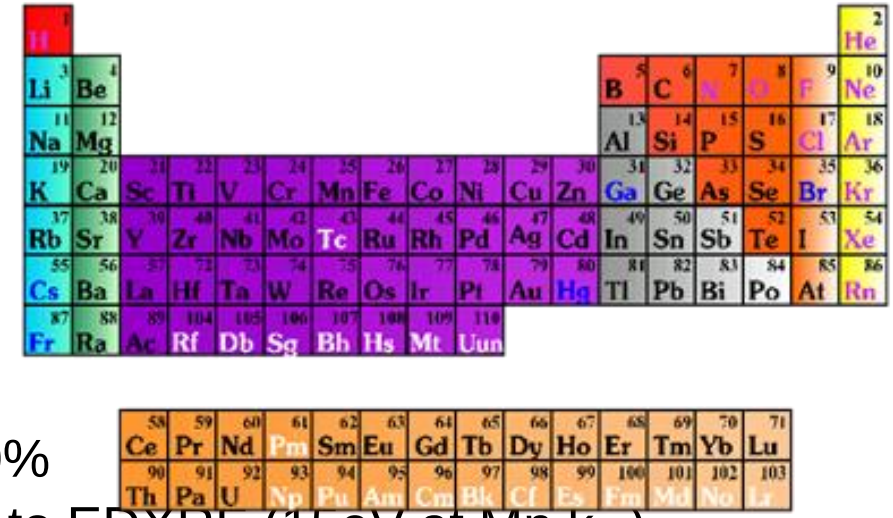
X-Ray Fluorescence
X-ray Diffraction

Applications and products

Thermo Fisher Scientific
1024 Ecublens, Switzerland

What is so great about WD X-ray Fluorescence ?

- Precise, non-destructive multi-element analysis of conducting and non-conducting samples:
  - Solids
  - Liquids
  - Loose powders
- Multi-element analysis: Be - F to U
- Inorganic and Organic materials
- High precision and highly reliable
- Wide dynamic range: sub-ppm to 100%
- Ten times better resolution compared to EDXRF (15eV at Mn kα)
- Better performance on light elements compared to EDXRF (better stability and limits of detection)
- Powerful **“standard-less”** elemental analysis for totally unknown samples



WDXRF, EDXRF and XRD: Elemental and Phase analysis of a variety of materials

- *Cement and building materials*
- *Metals, Slags, ferro-alloys*
- *Petroleum, Polymers, Oils*
- *Ores and raw materials*
- *Chemicals/Pharmaceuticals*
- *Geology, geochemistry*
- *Environmental, air filters*
- *Food products*
- *Mining extraction*
- *Universities, central labs*
- *Thin films, magnetic media, paints*
- *Etc.*

Thermo Scientific XRF and XRD Product Portfolio: Strong and complementary technologies

EDXRF

ARL QUANT'X
Advanced EDXRF

Portable Niton

WDXRF

ARL PERFORM'X
High Performance sequential XRF

ARL OPTIM'X: Surprising performance in WDXRF

Integrated XRF and XRD

ARL 9900 Series
Integrated XRF-XRD

Powder XRD

Equinox 6000: High performance Powder XRD

Equinox 100 & 1000
Benchtop XRD

XRF: Elemental analysis

XRD: Analysis of
Structure-crystallography
Phase or compound

Thermo Scientific EDXRF Spectrometer

ARL QUANT'X

- Most suitable for
  - Gemology
  - RoHS and WEEE compliance analysis
  - Forensics and Trace Analysis
  - Environmental analysis
  - Oils and gasoline
  - Polymers and plastics
  - Industrial minerals
  - Nutritional Supplements in Food
  - Aerosol Particulate Filters
  - Alternative fuels and backup in cement
  - Slags in steel industry

Thermo Scientific Wavelength Dispersive XRF systems

ARL OPTIM'X XRF

- Compact WDXRF instrument with a unique combination of sequential and simultaneous devices
- Amazing performance despite low power thanks to UCCO technology
- Choice of 50W or 200W power
- Excellent spectral resolution
  - Better accuracy and precision of analysis
- Markets
  - Raw materials
    - Slags, limestone, sand, feldspar, etc.
    - Ferro-alloys, aluminium or zinc ingots, etc.
    - Hot metal, irons
  - Food and Chemicals
  - Back-up in big cement and steel plants
  - Refineries (Sulfur Analyzer)

ARL Optim'X
with ARL SMS-Omega

ARL PERFORM'X series

- Highest performance sequential XRF spectrometers for qualitative, quantitative and standard-less analysis of almost any material
- Applications:
  - Central Laboratories, Research Labs, Materials Science
  - Geology centers, Petrochemicals, Polymers,
  - Environmental and process control

4200W

2500W

1500W

Versatile Goniometer

Integrated Large XY Sample changer

- New X-ray tube
  - 50µ Be window
  - Extreme stability

+ Mapping/Spots down to 0.5mm
+ Small samples down to 5mm
+ Helium for liquid/loose powders

Thermo WDXRF systems

ARL 9900 Series X-ray Spectrometer

- Compact, modular XRF instrument for rapid elemental sim/seq analysis
  - Up to 32 fixed channels
  - Up to 24 fixed channels with one universal goniometer
  - Dual goniometer + 8 fixed channels
- Applications:
  - Iron and Steel
  - Aluminum
  - Copper
  - Cement
  - Mining and metal extraction

Comparison of XRF and OES techniques: Typical precision on various elements in Steel

		ARL 9900 XRF	ARL 4460 OES
Element	Conc.	in 30s ppm	ppm
Si	0.002	2.6	0.6
Si	0.5	8.2	22
Si	1	11.4	40
Si	5	25.0	150
Mn	0.001	2	0.5
Mn	0.1	3.2	5
Mn	1	8.4	30
Mn	5	18.4	130
Mn	10	26.6	250
P	0.01	1.4	1
P	0.3	5.5	20
S*	0.01	1.3	2.5
S*	0.05	2.6	10
*Low Mo samples			

		ARL 9900 XRF	ARL 4460 OES
Element	Conc.	in 30s ppm	ppm
Cr	0.01	1.3	1
Cr	0.1	2.5	4
Cr	1	7.2	25
Cr	5	16.0	80
Cr	10	23	150
Al	0.001	1.7	0.3
Al	0.01	2.4	1
Al	0.1	5.5	9
Ni	0.001	2	0.8
Ni	0.1	4	3
Ni	1	10	25
Ni	10	32	250
Ni	30	110	750

ARL 9900 XRF – 3.6kW compared to ARL 4460 OES:
XRF is better at high levels – OES is better at low levels

Thermo Scientific Combined XRF-XRD systems

ARL 9900 Series X-ray Spectrometer

- Compact, modular XRF instrument for rapid elemental sim/seq analysis
- Specific phase analysis using **unique** patented integrated XRD system (e.g. Total Cement Analyzer - TCA)
- Applications for XRD system:
  - Cement
    - Free lime and clinker phases
    - Hot meal decarbonatation
    - Limestone additions to cement
    - Clinker content in cement
  - Iron and Steel
    - Fe 2+ in sinters
    - Free lime in slags
    - DRI
  - Aluminum
    - Bath ratio of electrolytic bath
  - Copper mining and metal extraction
    - Various phases (compounds)

NEW offer on XRD: EQUINOX 100 & 1000

EQUINOX 100 & 1000

Bench-top X-ray Diffractometers

- Ultra-fast unique Equinox curved detector
  - measures all diffraction peaks simultaneously
  - also called PSD for position sensitive detector

- Unique simultaneous XRD detection

Environment

Geology, Cement, Mining

Research

Metallurgy

Environment, Geology

Pharmaceuticals

Education

Polymers, Biomaterials

Electronics

Photovoltaic