

thermo scientific

Thermo Scientific ARL EQUINOX 3000 and 3500

X-ray Diffractometers



ThermoFisher
SCIENTIFIC

High performance at an affordable cost

Thermo Scientific™ ARL™ EQUINOX 3000 and Thermo Scientific™ ARL™ EQUINOX 3500 X-ray diffractometers (XRD) are designed to meet structural and phase analysis requirements in both industrial and research laboratories. These instruments are a cost-effective solution for routine QC/QA in industrial labs, dynamic studies, formulation determinations, research and development both at universities and industries.

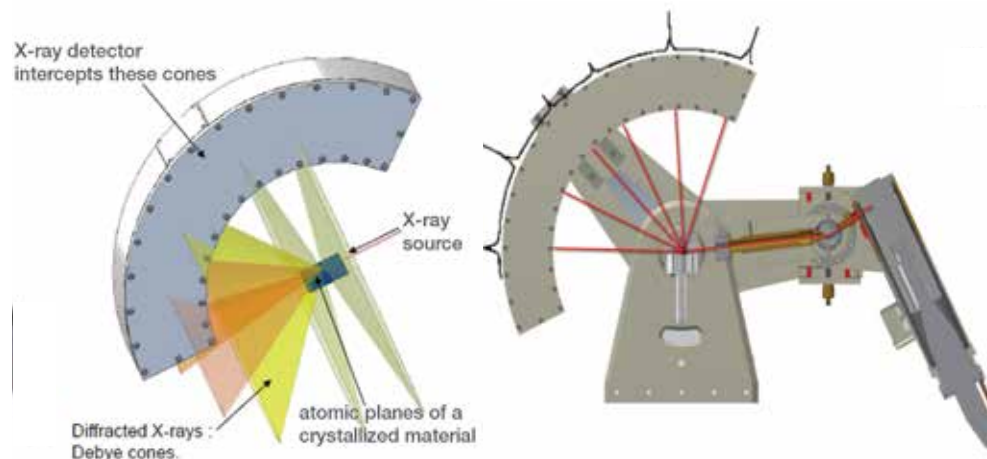
The ARL EQUINOX 3000 and 3500 instruments feature a unique curved position sensitive detector for real-time simultaneous acquisition of full pattern, enabling faster analysis, in situ experimentations, and crystalline phase development and phase transitions.

- Reliable and robust with no moving parts
- Full 3kW power instrument
- Real-time simultaneous data acquisition
- Versatile sample entry and analysis
- Configurable optics
- High resolution detector

Reliable and robust

Thermo Scientific ARL EQUINOX series is designed for laboratories ranging from production control to research applications. This X-ray diffraction (XRD) technology allows for greater flexibility and is quicker in process response times.

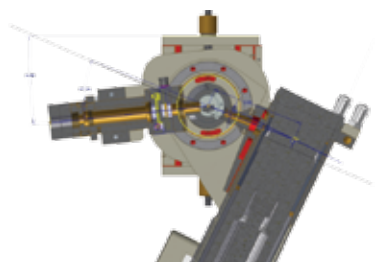
- Fixed goniometer system
 - Stationary X-ray source and detector
- Acquisition in asymmetric mode over $120^\circ 2\theta$ (ARL EQUINOX 3000 – CPS120 detector) or $90^\circ 2\theta$ (ARL EQUINOX 3500 – CPS590 detector)
- Fixed focal length
 - No realignment needed
- Monochromatic optic in $K\alpha_1$ or $K\alpha_{1/2}$
 - Focusing or parallel X-ray mirror
 - Germanium (111) and/or graphite (002) monochromator
- Large space for sample support environment



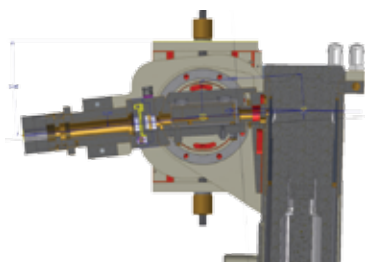
Resolution and high intensity in the same instrument

The ARL EQUINOX 3000 and ARL EQUINOX 3500 use a standard high power X-ray tube for sample excitation. For highest sensitivity and resolution the use of parallel or focusing X-ray mirror is recommended. Otherwise, the optical path can incorporate a monochromator to either increase sensitivity with graphite or resolution with germanium. The instrument can also include both monochromators in a single housing.

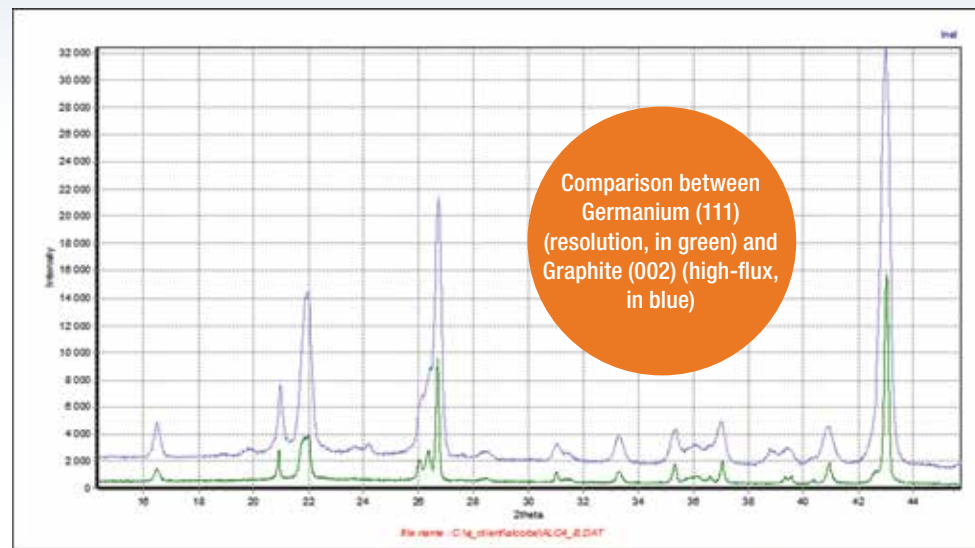
- Germanium monochromator Ge (111)
 - Acquisition privileging the resolution to flux
 - Pure $K\alpha$ 1 radiation only
- Graphite monochromator HOPG (002)
 - Acquisition privileging the flux to resolution
 - $K\alpha$ 1&2 radiation
- Focusing beam mirror
 - Focusing mirror for extreme intensity beam
 - High intensity with focal point on detector
 - $K\alpha$ 1&2 radiation
 - Ideal optic for measurements in a very short time like dynamic studies
- Parallel beam mirror
 - High intensity with a parallel beam
 - $K\alpha$ 1&2 radiation
 - Ideal optic for measurements in a very short time like dynamic studies



1D monochromated schematic



1D mirror schematic



Sample of pozzolana, peaks at $\sim 26 / 27^\circ 2\theta$ – better separation of peaks with a Germanium monochromator

Detector options

ARL EQUINOX 3000 and the CPS 120 detector

- Higher resolution and more versatility than our benchtop models (ARL EQUINOX 100 and ARL EQUINOX 1000)
- 0° to 120° simultaneous 2θ acquisition in asymmetric geometry
- Distance between the sample and the detector: 250 mm
- Ideal for phase identification, quantification and Rietveld analysis
- Ideal for in-situ applications (high and low temperature, etc.)



ARL EQUINOX 3500 and the CPS 590 detector

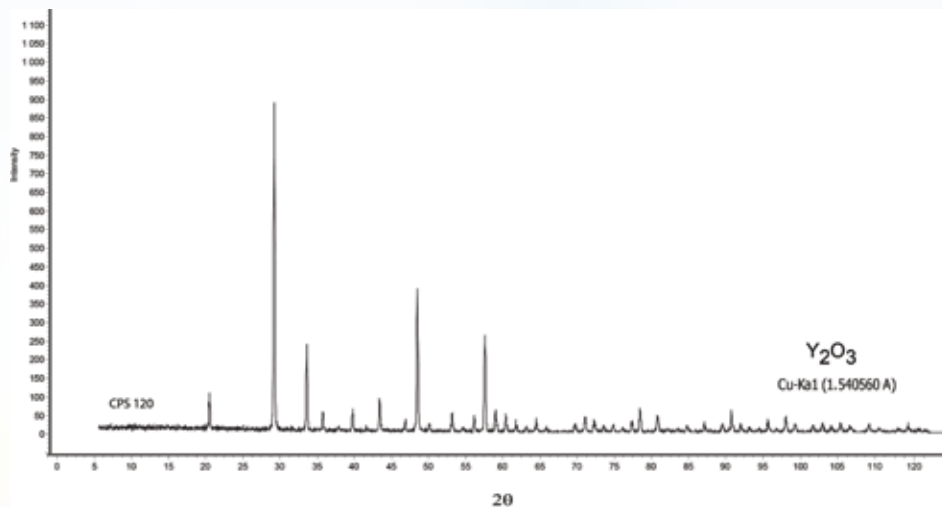
- Superior resolution compared to the CPS 120
 - FWHM (Full Width Half Max) is divided by 2
- 0° to 90° simultaneous 2θ acquisition in asymmetric geometry
- Distance between the sample and the detector: 500 mm
- Ideal for data with a high resolution or at very low angle



Analytical performance

Analysis of materials ranging from minerals to pharmaceuticals can easily and accurately be performed using the ARL EQUINOX 3000 and ARL EQUINOX 3500. The resolution and speed of the instrument is exceptional thanks to simultaneous acquisition of the whole pattern. Everything from phase identification, quantitative, percent crystallinity calculations and even crystal structure solution and refinement can be performed with these X-ray diffractometers.

- Phase identification
- Quantification
- Degree of crystallinity
- Cell parameters
- Crystallite size
- Lattice strain
- Crystal structure
- Rietveld analysis
- Transition phase
- Thin film analysis (grazing angle, reflectometry...)



Acquisition on Y₂O₃ powder recorded on an ARL EQUINOX 3000 in reflection mode with a resolute optic (germanium monochromator)

Real time simultaneous data acquisition

The CPS real time detectors are unique acquisition tools that collect all diffraction data simultaneously. These detectors enable the user to perform diffraction experiments on powders, bulk material and thin films all in real time, enabling not only fast analysis but also dynamic studies.

Versatile sample entry and analysis

The ARL EQUINOX 3000 and ARL EQUINOX 3500 are versatile XRD instruments adapted for several sample types in various analytical conditions. Sample adaptors are easily switched in the matter of seconds without tedious re-alignment needed each time. Accessory stages are as follows:

- Fixed non-spinning sample stage
- Single position spinning stage for reflection and transmission
- Reflection mode spinning stage with height adjustment
- Controlled atmosphere reflection sample stage
- Capillary transmission sample stage
- 30-position automatic sample changer with spinning sample holders
- GIXRD thin layer analysis stage
- Temperature controlled stage
- Gandolfi chamber
- Other controlled stages (humidity, environment, etc.)

A large selection of sample holders for advanced XRD



Spinning stage for powder sample

- Reflection and transmission mode on powder
- Continuous sample rotation
- «Zero background» holder for sample in micro quantity
- Special cups for air sensitive sample protection



Spinning stage with height adjustment

- Reflection mode on powder and bulk
- Sample maximum size: 40x20 mm with a centered sample
- Height adjustment on 30 mm
- Continuous sample rotation



Spinning sample holder for studies on filter

- Specific measurement in reflection mode on filter
- Continuous sample rotation
- Available with Silver membrane filter of 25 mm diameter



Spinning stage for pressed pellet

- Reflection mode on cement, minerals and other powders
- Continuous sample rotation
- Choice according to customer's specifications
 - C1: 51 mm steel rings, Polysius ring
 - C2: 40 mm steel rings, Herzog ring
 - C3: 40 mm pressed pellets



Sample stage with controlled atmosphere

- Reflection mode on powder
- Continuous sample rotation
- Modes of operation:
 - Completely isolated cell with closed connections
 - Gas control in the cell
 - Gas circulation for atmosphere recycling

A large selection of sample holders for advanced XRD



Automatic sample changer

- 30 sample positions in reflection mode
- Continuous sample rotation
- «Zero background» holder available



Capillary stage for transmission measurement

- Transmission mode on sample in capillary
- Goniometric head support
- Continuous sample rotation
- Borosilicate or quartz capillaries available with a diameter from 0.1 to 3.5 mm



Thin layer attachment

- Specific attachment for thin film application
- Sample size up to 25x25x10 mm
- High accuracy motors in θ and Z adjustments
- Excellent for Grazing Incidence (GIXRD)
- X-Ray Reflectometry (XRR)



Gandolfi chamber

- Specific attachment used to obtain a powder pattern from a single crystal or a small cluster of crystals
- Crystal holder with 2 continuous sample rotation device
- Sample mounted on capillary
- Ex-situ adjustment camera



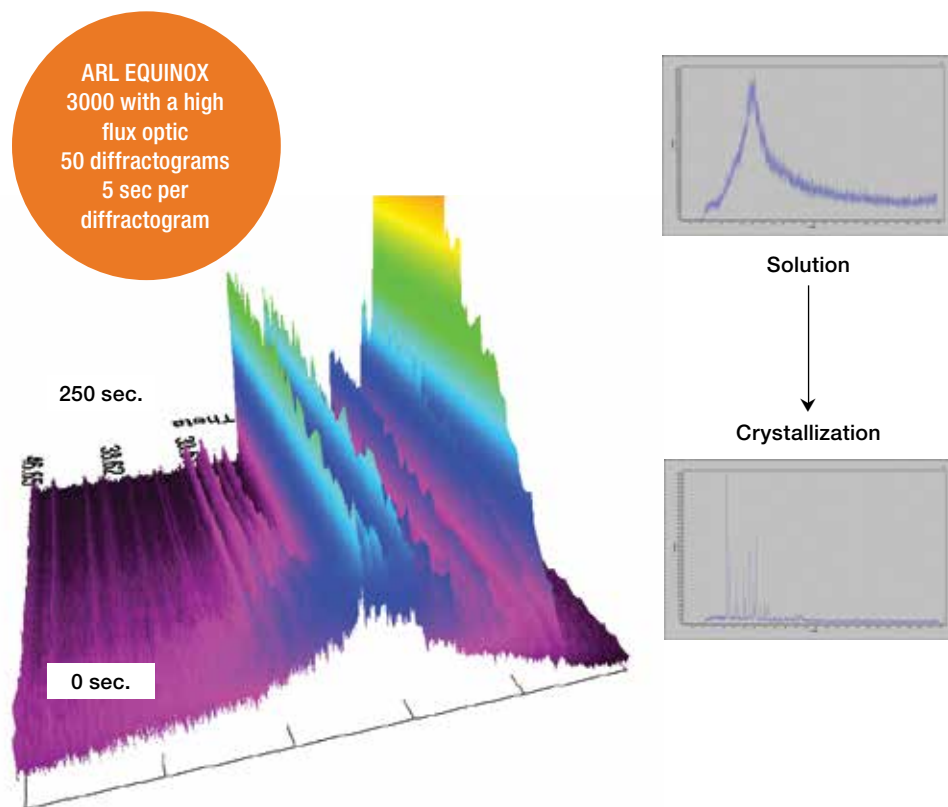
In-situ attachments

- High temperature
 - Transmission or reflection mode
 - Up to 1200 °C with spinner holder
 - Beyond 1200 °C with a maximum of 2700 °C
 - Gas flow or vacuum available
- Low temperature
 - Low temperature down to -190°C
 - Transmission or reflection mode
- Humidity
- Tensile stages

Dynamic studies

Studies of physical and chemical properties of materials, as a function of temperature, environment, pressure and other conditions, require dynamic crystallographic measurements in real time. Structural phase transitions or modifications of materials can be captured as they occur thanks to Position Sensitive Detectors (PSD). The PSD acquires the complete XRD spectrum simultaneously, ensuring that no transition is missed during a measurement, which is especially true with unstable compounds.

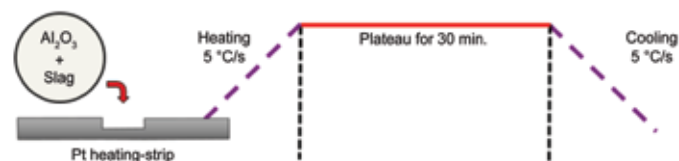
Crystallization of a pharmaceutical product in a concentrated solution



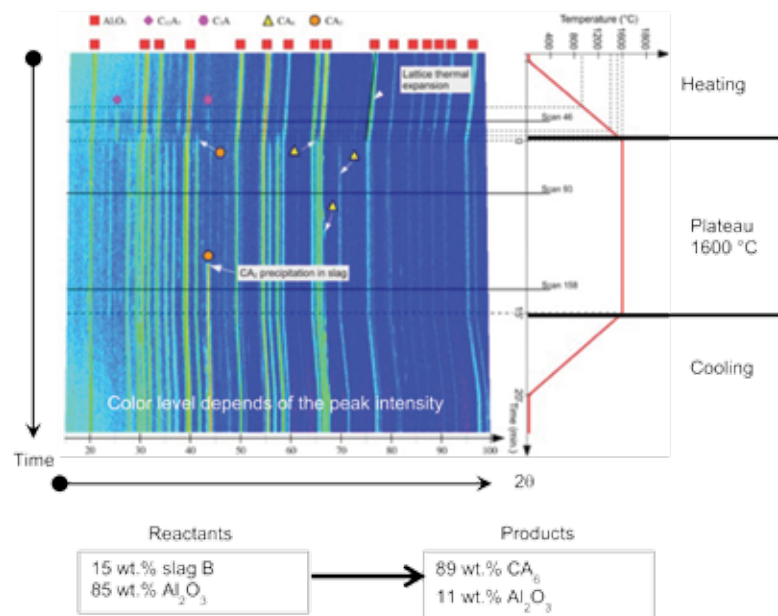
A weak volume of a concentrated solution in an organic product, dissolved in methanol, is set on a sample holder.

Corrosion tests with 15 wt.% of binary slag at 1600 °C

• Operating procedure



- ARL EQUINOX 3000 with a high flux optic equipped with a high temperature chamber HTK 16N from Anton Paar
- ~300 diffractograms with 5 sec per diffractogram



ARL EQUINOX 100

X-ray diffraction portfolio

Thermo Fisher Scientific offers a broad X-ray diffraction portfolio using Position Sensitive Detectors (PSD) from simple bench-top instruments to the most advanced platforms which enable material scientists and engineers to perform qualitative, quantitative and advanced structural investigations on a variety of materials. Applications vary from routine QC/QA related phase quantification in industrial process control to real-time determination of structures, texture, residual stress, polymorphism, reactivity or kinetics of advanced materials in the form of powders, solids, or thin films. Thermo Scientific X-ray Diffraction products are designed to exceed your analytical needs.



ARL EQUINOX 1000



ARL EQUINOX 5000

Find out more at thermofisher.com/xrd