

# SPECTROMETRY SOLUTIONS

## ARTAX $\mu$ XRF SPECTROMETER



# ARTAX – Elemental Analysis for the Art Community and More...

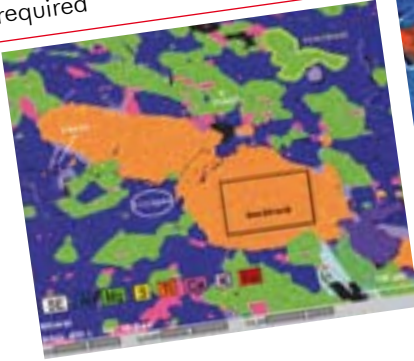
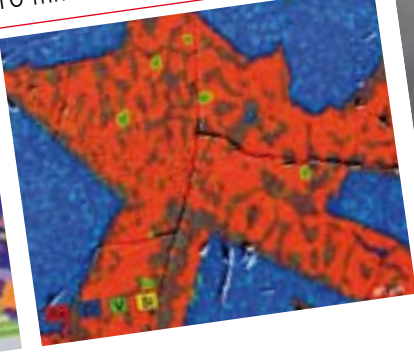

Non-destructive elemental analysis is strictly required for testing many kinds of samples.

- Origin or age determination of unique and valuable art objects
- Investigations on objects that secure evidence in forensic sciences
- Final testing of industrial products
- Materials research, especially when a limited amount of sample is available or material recovery is essential

Micro X-ray fluorescence analysis ( $\mu$ XRF) is the most suitable technology for these requirements.

- $\mu$ XRF delivers the most detailed information possible on the materials composition and/or structure
- Objects are not damaged or altered by  $\mu$ XRF analysis
- The analysis can be done at the location of the object of interest with a mobile configuration of the spectrometer

Bruker AXS offers a complete range of  $\mu$ XRF spectrometers. Different configurations are available to meet your application and budgetary needs.

| X-Ray Microanalysis (EDS)   | Micro X-ray Fluorescence Analysis ( $\mu$ XRF)                                       | X-Ray Fluorescence Analysis (XRF)   |
|---|--|---|
| <b>Capability</b><br>High resolution element mapping in the sub- $\mu$ m range      | <b>Capability</b><br>Non-destructive spatial investigation of element distribution   | <b>Capability</b><br>Elemental analysis of bulk samples                               |
| <b>Limitation</b><br>Destructive sample preparation required                        | <b>Limitation</b><br>Analytical range of 10 $\mu$ m to 10 mm                         | <b>Limitation</b><br>No information about spatial element distribution                |
|  |  |  |
| nm - $\mu$ m  | $\mu$ m - mm   | mm - cm   |

**The ARTAX is the first portable X-ray fluorescence (XRF) spectrometer** designed to meet the specific requirements for non-destructive elemental analysis.

ARTAX is suitable for multielement analysis of Na(11) to U(92) and offers a spatial resolution down to 70  $\mu\text{m}$ . Fast, high-resolution elemental analysis is possible with ARTAX because of its innovative measuring head design.

The ability to combine ARTAX options into a system uniquely tailored to your needs ensures maximum flexibility for a wide range of applications.

- Archeometry
- Restoration and conservation
- Process-related quality control
- Forensic sciences
- Research and development of advanced materials



ARTAX testing Piero di Cosimo's painting "The Holy Family"

| ARTAX features                       | User benefits  |
|--------------------------------------|--|
| Portable instrument design           | Direct, on the spot examination of valuable or immovable objects   |
| Compact, open system                 | Enables the examination of large and uneven objects<br>No sample preparation required                              |
| Polycapillary lens for beam focusing | Highest spatial resolution possible<br>Extremely high fluorescence intensity reduces measurement time              |
| XFlash® Silicon Drift Detector (SDD) | Liquid nitrogen as cooling agent not required<br>High count rate results in short measurement times                |
| Helium purging                       | Immediate measurement of light elements from Na(11) to Ar(18)<br>Avoids vacuum, which might damage fragile samples |
| XYZ stage                            | Reproducible positioning of the measuring head   |



# The Heart of ARTAX – the Measuring Head



**The ARTAX is equipped with a measuring head** featuring the most advanced technology for precise and fast data acquisition.

Outstanding components include the XFlash<sup>®</sup> Silicon Drift Detector (SDD) and an innovative exchangeable excitation source.

**The polycapillary lens** of the ARTAX creates a microspot ( $< 100 \mu\text{m}$ ) of primary X-radiation with high intensity. Polycapillary lenses are an ensemble of several thousand glass capillaries which form a united monolithic structure.

In comparison to a pinhole collimator, the fluorescence intensity of a polycapillary lens is increased by a factor of more than 1000.

**The XFlash<sup>®</sup> energy-dispersive detector** analyses the X-ray fluorescence. This Peltier cooled silicon drift detector operates nitrogen-free with high-speed, low-noise electronics. It has significantly better energy resolution and higher count rates than PIN diode detectors. This allows fast measurements during line scans and element mappings.

|                   | PIN diode          | XFlash                  |
|-------------------|--------------------|-------------------------|
| % Deadtime        |                    |                         |
| at 2,500 cps      | $> 20 \%$          | $< 0.5 \%$              |
| at 25,000 cps     | $> 75 \%$          | $< 6 \%$                |
| Energy resolution |                    |                         |
|                   | $> 200 \text{ eV}$ | $< 160 \text{ eV}$      |
|                   |                    | opt. $< 145 \text{ eV}$ |

**The integrated CCD camera** shows a magnified image of the sample region under investigation. A white LED illuminates the sample to optimise the image quality and contrast. Pictures are automatically stored for documentation purposes.

# Change Your **Excitation** - it's as Simple as That !

The **excitation source** is fitted with a high precision lock, which allows the fast exchange of the X-ray tube housing. This enables you to choose the most suitable excitation and quickly exchange the X-ray optics. Including warm-up, the switch of the tube can be done in less than 15 minutes.

Mo or W? Both! An X-ray tube with a W target generates 2 to 5 times larger peak areas for K-line elements above 20 keV (e.g. Ag, Sn, Sb) than one with a Mo target. In contrast, the Mo tube has the major advantage of significantly better light element detection. The ARTAX allows the fast and easy application of both W and Mo X-ray target materials for advanced analysis of any kind of sample.

The **exact position of the beam on the sample** and the exact distance between object and spectrometer is controlled via a laser diode. The laser spot is adjusted to the focus of the mini-lens and is visualised by the camera.

The movement of the measuring head is controlled by a XYZ stage, which is suitable for fast line scans and element mappings. Powerful software creates area images of the element distribution across the sample.

The open design of the spectrometer head together with a distance of about 10 mm to the sample enables access to uneven or structured samples.



- A touch sensor immediately triggers an emergency stop of the XYZ stage when the head moves too close to the sample
- Easy integration of additional warning lamps, door interlocks, etc.
- Integrated flow controller for the He purge control and "empty bottle" alarm

# Successful in Art, Forensics and Industry

## Iron gall inks in manuscripts

Thin ink layers on paper are very inhomogeneous and do not allow reproducible point measurements. Therefore, line scans of 10 measurements each were acquired and subsequently accumulated for calculation of the average element content. The excitation by the Mo tube and polycapillary lens allowed the analysis of fine ink strokes.

The amounts of trace elements like Zn, Cu and Mn were calculated, leading to an origin and chronological classification of the work.

Johann Sebastian Bach Serenade



## Altarpiece with metal leaf applications

Thin layers of gold and silver approximately 1  $\mu\text{m}$  thick were investigated by single point measurements with a W target tube and 0.65 mm collimator. The W target guaranteed high sensitivity for silver traces.

Layers of pure silver, 23½ carat "Rosenobelgold" and historical gold sorts like green gold (30% Cu) and "Zwischgold" (Ag and Au layers hammered together) were characterized.

Göttingen Barfüßer altarpiece (1424)

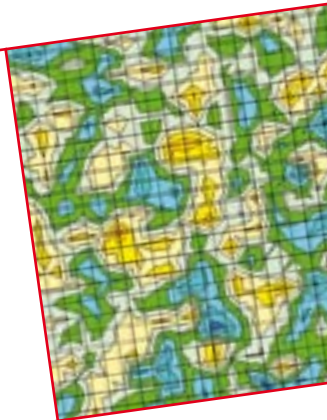


## A polymer mould with fine structures formed by Cr, Cu and Fe

2D mapping of a 3x3 mm area (30x30 measurements, 100  $\mu\text{m}$  step-width, 3 s per point) with Mo tube and polycapillary lens.

The element distribution of the key elements was measured, leading to the determination of relative concentrations across the sample.

Chromium distribution in a polymer mould

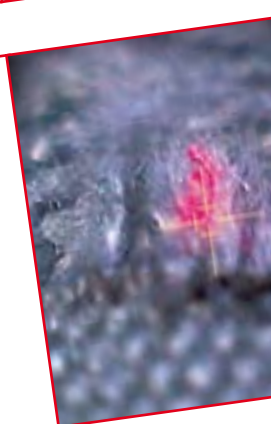


## Tissue with particles attached after gun shot

2D mapping of a 2x2.5 mm tissue (20x25 measurements, 100  $\mu\text{m}$  step-width, 5 s per point) with Mo tube and polycapillary lens.

Identification of particles down to 10  $\mu\text{m}$  in size. Particle distribution across the tissue allowed the exact determination of the incidence angle of the gun shot.

Tissue with gun shot residue



# Three Solutions – No Analytical Compromise

**The outstanding performance of the ARTAX** is based on the design of the measuring head and the integration of the most modern components. The same measuring head is included in all ARTAX systems. This guarantees the highest data quality – without compromise.

- Exchangeable excitation source with air-cooled X-ray tube
- Liquid nitrogen-free XFlash® Silicon Drift Detector, 160 eV resolution
- Integrated CCD camera with sample illumination and laser spot
- Compact control unit including high voltage generator
- ARTAXControl for semi-quantitative XRF analysis

Users have different requirements for their  $\mu$ XRF spectrometer: the number of samples, the analytical procedure, the need of mobility and the financial resources.

Consequently Bruker AXS offers three ARTAX configurations, each fully upgradable at any time.

- ARTAX 200 – Small labs with a limited number of samples, independent conservators, high need for mobility
- ARTAX 400 – Labs with medium requirements, need for 1D and 2D mappings
- ARTAX 800 – Labs with high-level requirements, numerous samples, fast sample throughput

The ability to customize your ARTAX as needed ensures that it will meet your requirements now and in the future.

## **Accessories for the ARTAX systems**

- Second excitation source, tube housing, X-ray tube, collimator or polycapillary lens, target of your choice (W, Rh, Cu, Ti)
- Additional filter assembly for improving the signal to noise ratio
- Collimator set: 0.2 mm, 1.0 mm, 1.5 mm
- Acrylic glass shielding for protection against scattering



| Specifications of the ARTAX systems  | 200    | 400    | 800    |
|--|--------|--------|--------|
| <b>Basic system</b>  |        |        |        |
| Compact control unit with high voltage generator, 50 kV, 50 W  | ✓      | ✓      | ✓      |
| Option for light element detection starting from Na<br>Helium gas flow of the excitation and detection paths   | option | ✓      | ✓      |
| <b>Measuring head</b>  |        |        |        |
| Colour CCD camera, 500x582 pixel, ca. 20times magnification<br>Dimmable white LED for sample illumination<br>Laser spot for reproducible positioning of the measuring head                                       | ✓      | ✓      | ✓      |
| <b>Detector</b>  |        |        |        |
| Peltier cooled XFlash <sup>®</sup> Silicon Drift Detector, 10 mm <sup>2</sup> active area<br>Energy resolution < 160 eV for Mn-K $\alpha$ at 100 kcps<br>Max. count rate > 100 kcps, dead time < 10 % at 40 kcps | ✓      | ✓      | ✓      |
| Detector upgrade, energy resolution < 145 eV, Mn-K $\alpha$ at 100 kcps  | –      | option | option |
| <b>Exchangeable excitation source</b>  |        |        |        |
| X-ray tube housing with precision lock for simple exchange<br>Incl. electro-mechanical shutter, two absorption filters   | ✓      | ✓      | ✓      |
| Air-cooled Mo X-ray fine focus tube*, max. 50V, 1 mA, 50 W<br>Exchangeable collimator, 650 $\mu$ m   | ✓      | ✓      | –      |
| Air-cooled Mo X-ray micro focus tube*, max. 50V, 1 mA, 30 W<br>Polycapillary lens for micro excitation spot (intensity gain > 1000)<br>Lateral resolution < 100 $\mu$ m, for excitation up to Sb K-line          | –      | –      | ✓      |
| <b>Mounting</b>  |        |        |        |
| Tripod for free positioning of the system, incl. rolling scates<br>Free rotatable arm and variable height adjustment (500 to 1500 mm)  | –      | ✓      | ✓      |
| XYZ stage with stepper motors, 50 mm range<br>ARTAX 1D and 2D mapping software   | –      | ✓      | ✓      |
| Light-weight tripod, optimally suited for mobile use   | ✓      | option | option |
| <b>Software</b>  |        |        |        |
| ARTAXControl semi-quantitative XRF software for hardware control and data evaluation   | ✓      | ✓      | ✓      |
| ARTAXQuant standards-based software  | option | option | option |
| Notebook computer  | option | ✓      | ✓      |

\* W, Rh, Cu and Ti tubes available on request

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