M4 TORNADO

The M4 TORNADO offers the best performance in micro-X-ray fluorescence analysis. The main advantage of this technique is the spatially resolved elemental analysis, which allows single particles, inclusions or even inhomogeneous samples to be easily analyzed.

The frequently inhomogeneous structure of technical materials determines their macroscopic properties, which are responsible for the mechanical, electrical or magnetic performance. This explains the necessity of determining the element distribution both parallely and perpendicularly to the surface.

The M4 TORNADO belongs to the latest generation of µ-XRF spectrometers. Easy sample handling, fast measurements and a wide range of standardless quantification routines are some of its highlights. Moreover, the system offers several special features including a large vacuum sample chamber, high spatial resolution and intensity due to smallest spot size, and a fast stage for distribution analysis.

Due to these technological advantages, the M4 TORNADO is the instrument of choice for applications in materials science, forensics, archeometry or microelectronics fields. Material testing, quality control, layer system analysis, search of toxic elements, and a lot of further analytical tasks can be solved with this instrument.

Effective excitation of fluorescence

The use of polycapillary X-ray optics permits the generation of high fluorescence intensities even from the smallest sample areas. The X-ray optics accumulate tube radiation from a large solid angle and concentrate it on spots down to 25 µm for Mo-K. The excellent spatial resolution and the small step size of the stage allow the analysis of small particles, inclusions and inhomogeneous samples.

The possibility of using two X-ray tubes permits very effective excitation of special groups of elements by choosing different target materials or by using one tube with a collimator. This is especially relevant for the excitation of elements with a high atomic number.

Accurate spectrum acquisition

The M4 TORNADO uses Bruker's XFlash® silicon drift detector (SDD) technology, which combines count rates up to 500 kcps with energy resolution down to 145 eV. The 30 mm² active area allows the collection of radiation from a large solid angle. The high count rate guarantees high accuracy in quantitative analysis and fast distribution analysis.

The use of to 2 detectors in special applications doubles the count rate and supports the identification of Bragg-reflexes.

The stage's travel speed of up to 200 mm/s combined with "on the fly" measurement keep the time required for distribution analysis low. Information on element distribution can already be obtained with an acquisition time of 1 ms per pixel.

Easy and fast sample handling

Highest user comfort and easy handling are important features of the M4 TORNADO. They are achieved through:

- EasyLoad function with motorized sample chamber door, stage movement to load position and control of the vacuum pump
- Large chamber for sample size up to 600 x 350 x 260 mm
- Sample positioning supported by fisheye camera and two optical video microscopes that show approx. 1 mm² and 10 mm²
- Auto focus function for setting the sampe height correctly
- Mosaic (tiled) images of high quality (stitching, shadow correction) for large area maps
- Distribution analysis with HyperMap, which collects complete data sets and supports offline data evaluation.

Flexible quantification models

The quantification of inhomogeneous samples requires standardless analysis based on FP-models. The software option M-Quant calculates peak intensities with help of the Sherman relation. A complete spectrum is calculated from these intensities by full pattern fitting. This procedure also allows the consideration of the stoichiometric relations and the transmission function of the X-ray optics as well as the improvement of accuracy through reference samples. Another important feature of M-Quant is the estimation of uncertainty of quantification results considering statistical errors, peak overlaps, background fitting and errors in fundamental parameters.

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