New Dimensions in Micro-XRF Elemental Analysis

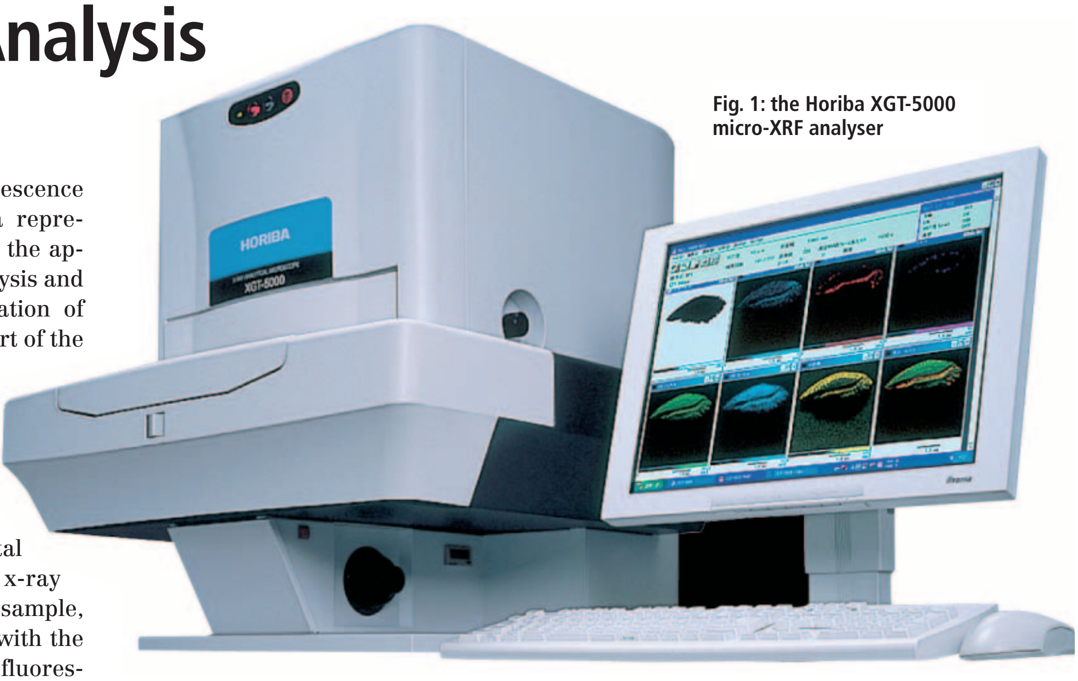

Fig. 1: the Horiba XGT-5000 micro-XRF analyser

Innovation in Micro-XRF

The new XGT-5000 x-ray fluorescence microscope system from Horiba represents an exciting development in the application of elemental micro-analysis and mapped imaging. The incorporation of unique technology within the heart of the instrument opens up the technique to new and exciting research areas.

Energy dispersive XRF has long been a useful analytical tool for macro sampling, providing fast, high sensitivity elemental characterisation. An integrated x-ray generator is used to irradiate the sample, and the interaction of the beam with the sample results in the emission of fluorescence x-rays. It is these emitted x-rays which are characteristic of the elements in the sample, and provide XRF with its powerful elemental analysis.

Whilst bulk XRF analysis is routinely performed, the extension of XRF into the microscopic domain is less trivial. Typical methods of obtaining narrow x-ray beams result in extremely low intensities, resulting in impractically long acquisition times. In addition, the need to subject samples to high vacuum conditions prevented micro-XRF analysis of fragile, powdered, water containing or biological samples.

New developments at Horiba have revolutionised techniques for producing the required narrow x-ray beam for micro-XRF, by using a unique mono-capillary x-ray optic. The result is high intensity, narrow beams which are optimised for microscopy, with beam diameters down to just 10 µm. The improved coupling efficiency means that samples can now be analysed at atmospheric pressure (even for light elements), and up to fifty times faster than previously possible.

As if this weren't enough, the improved beam quality provided by the XGT instruments allows x-ray transmission images to be acquired simultaneously, providing valuable information on internal structure too.

The era of micro-XRF is truly born!

Wider Applications

This coming of age of micro-XRF in the form of the XGT-5000 has seen researchers across the world embrace the instrument for a huge variety of applications. Its capabilities have proven invaluable for research in forensic science, pharmaceutics, electronics, geology, archaeology, metallurgy, chemistry, biology, and medicine – in fact any research requiring non-destructive high sensitivity elemental microanalysis and imaging.

Pharmaceutical

In the pharmaceutical environment, there is a constant pressure to ensure a product's quality and efficacy, both of which can be severely compromised through manufacturing processes, such as blending and compressing. Troubleshooting remains an important task, in order to identify problems which could occur at any stage in a long production line. XRF analysis with microscopic resolution allows tablet composition to be analysed for aggregation, crystal size, and dispersion, all of which can effect tablet performance. In addition, the fast material identification possible with XRF makes the technique an ideal trouble shooting tool.

In one example, micro-XRF located and identified a small steel fragment deep within a tablet (Fig. 2), introduced during the manufacturing process. The penetration depth of x-rays depends upon the matrix, but for typical lighter elements found in tablet formulations, analysis can be made several mm within the sample. In this case, the particle, almost invisible to the eye, was clearly visualised and identified with XRF. Other methods to identify the particle would have required its removal and subsequent chemistry, so the speed and simplicity of micro-XRF is clear.

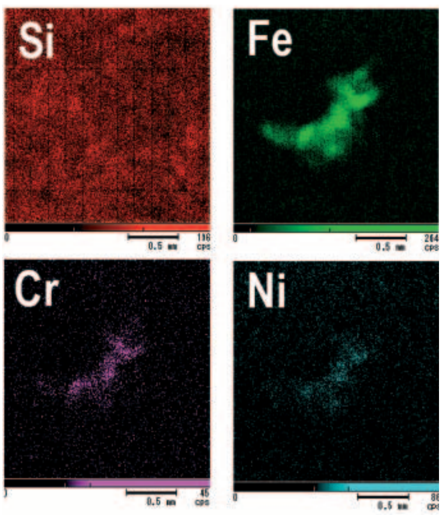

Fig. 2: XRF mapped image intensities of silicon (Si), iron (Fe), chromium (Cr) and nickel (Ni).

Biology

Whilst XRF has traditionally been used in the materials, geological and electronics areas, the new advances in technology which allow samples to be analysed at atmospheric pressure have been warmly welcomed by biologists amongst many.

An example of the power of micro-XRF is in the analysis of leaves from a

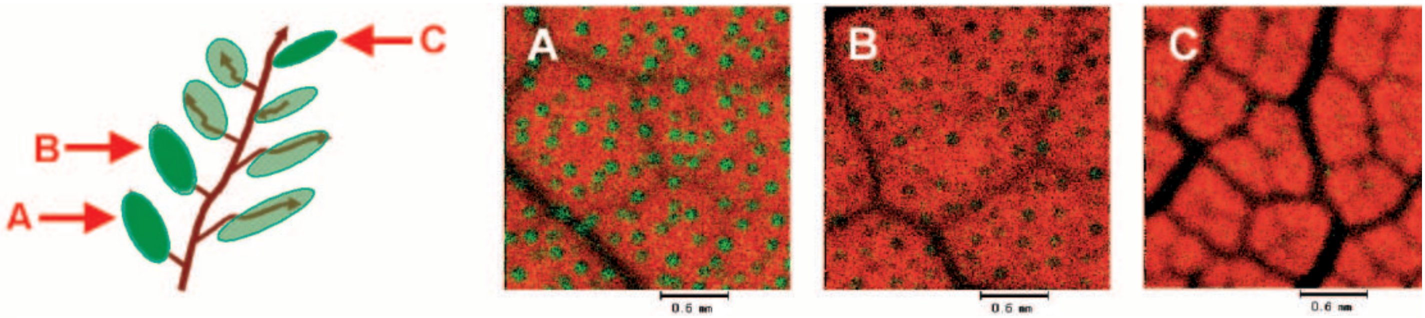

Fig. 3: XRF composite images of transmission and calcium (Ca) intensities acquired from mulberry leaves in different growth stages (A) old, (B) middle aged, (C) young.

mulberry plant (Fig. 3), which has identified the accumulation of calcium containing nodules as the leaves get older. These nodules, typically in the order of 150 µm in diameter are virtually non-existent in new leaf growth, but analysis of older leaves in the plant illustrates a dramatic increase in their concentration. Such research sheds lights on the growth and performance of silkworms, for which mulberry leaves are a valuable food source. A few years ago, such analysis would have been unthinkable – high vacuums would have quickly destroyed the biological integrity of the sample.

The XGT-5000 pushes the boundaries of imaging, by adding a new dimension – not just pretty pictures, but elemental composition too. It is clear that micro-XRF is now truly a tool for everyone, and not just a select few. Just think of the problems it could solve for you!

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