HORIBA Scientific

Application Note

Biology Life Sciences

XGT

XGT01

Biological applications of XRF microscopy

X-ray fluorescence (XRF) micro-analysis provides the research with a fast and non-destructive means of measuring elemental composition on a microscopic scale. However, it has long been a drawback of the technique that analysis must be carried out under vacuum conditions. Whilst for many applications this presents no problem other than inconvenience and time, within biological fields it means that many desired experiments are simply not possible. The vacuum conditions will quickly dehydrate and damage the typical water containing samples (leaves, micro-organisms, tissue, cells etc) key to biological/medical research. However, the unique x-ray guide tube technology of the XGT-5000 now allows high spatial resolution analysis for all elements from sodium (Na) to uranium (U) at atmospheric pressure – hence, hydrated samples, fine powders, and even liquids, can now be safely analysed for composition (quantitative and qualitative) and element distribution.

Gastric Ulcers and the Role of Zinc

Analysis of biological tissue is ideally suited to the XGT technology, and the opportunity was taken to investigate the role of zinc in the healing of gastric ulcers. Initial analysis of an entire rat stomach with a pronounced ulcer shows increased zinc concentration in the periphery of the ulcer (Figure 1). This result was obtained without any medication being applied, and suggests that naturally occurring zinc within the body is accumulated at the ulcer site to aid healing.

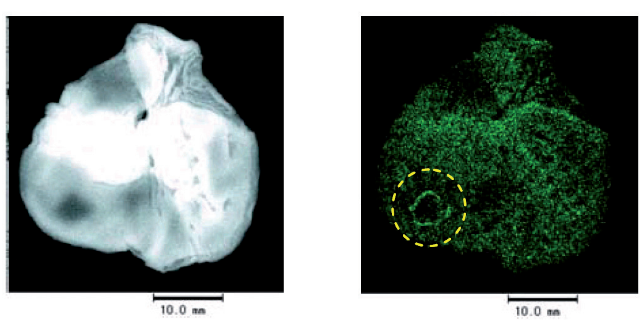

Figure 1: (Left) Transmitted x-ray image and (right) zinc XRF intensity image of ulcerated rat stomach without medication. The ulcer region is circled.

In Figure 2, the image taken after treatment with a zinc containing drug shows very strong zinc concentrations throughout the ulcer region. This indicates the effectiveness of treatment for delivering zinc to the ulcer, above and beyond the presence of naturally occurring zinc in the body.

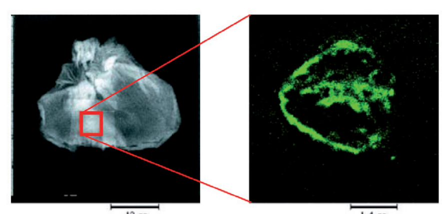

Figure 2: (Left) Transmitted x-ray image and (right) zinc XRF intensity image of ulcerated rat stomach following medication. The XRF image is taken from the highlighted region.

Otolith of horse mackerel

The otolith (or "earstone") of a fish is formed as a result of the stratification of any lime secreted from the inner wall of a fish head. The rate at which the otolith grows depends on the temperature of sea water and other such environmental factors, and as a result each one is unique in terms of its central 'ditch' and growth rings. It is believed that there is some correspondence between the otolith's structure and the age of the fish.

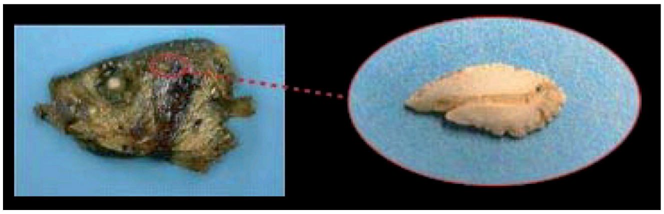

Figure 3: Horse mackerel head, and close up of otolith

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Analysis of the patterns (day growth rings) of otoliths is considered to be one of the most promising tools in studies of the life of fish. In addition, it is also stated that the ratio of trace elements within the otolith structure is associated with the living environment of the fish. Studies have been made to use such ratios in combination with the analysis of day growth rings in order to aid in conservation techniques.

Figure 4 shows mapping results from a typical otolith with the XGT-5000, clearly illustrating the 'ditch' and patterning on the bone. The unique 10 µm spatial resolution allows the elemental composition of these intricate features to be distinctly imaged.

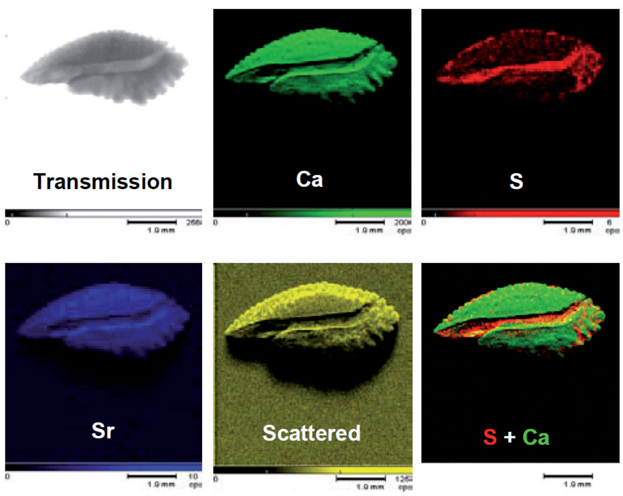

Figure 4: Micro-XRF mapped images of otolith.

Summary

The innovative XGT technology allows fast and convenient XRF analysis of biological samples, with a spatial resolution down to 10 µm. Drug interactions and healing processes can be quickly studied without damage to the sample, and characterisation of biomaterials such as bone provide in-sight into organism growth and life cycles.

Acknowledgements

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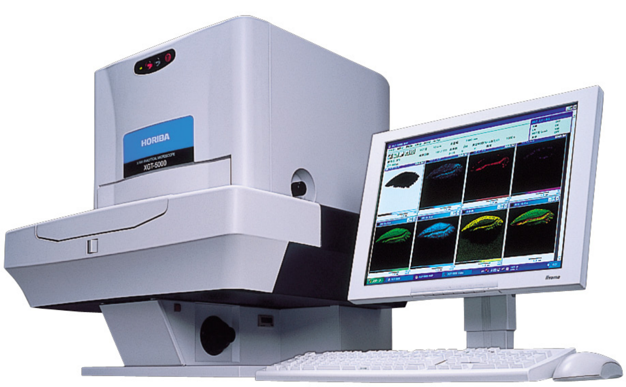

XGT-5000

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