HORIBA
Scientific

Application Note

Forensics

XGT

XGT7

X-ray micro-analysis for pearl characterisation in forensic science

Researchers and analysts in forensic labs and customs centres across the world use a wide range of techniques to provide materials analysis of many different sample types, including paints, pigments, gemstones, plastics, glasses, fibres, bodily fluids and narcotics.
X-ray micro-analysis elemental characterisation lends itself well to such analysis since the technique ensures preservation of evidence thanks to its non-destructive nature. The ability to analyse even small fragments and particles makes micro-XRF applicable to real life situations where often only very small sample volumes are available.
The award winning XGT-5000 presents the analyst with unique capabilities in a convenient bench top platform. A groundbreaking 10 µm analysis spot size ensures even microscopic particles can be quickly and accurate analysed, whilst the capability for transmission x-ray imaging provides information not available in older XRF instruments.
This application note explores how simultaneous XRF and transmission x-ray imaging is a unique tool allowing customs officials to quickly characterise pearls.

Pearl basics

Whilst pearls are a well known fashionable item, often fetching high prices on the high street, there is a wide range of pearls available with varying value based upon their composition and provenance.
The three main classifications of pearls are natural, cultured and imitation. Natural pearls are formed when a small irritant is trapped inside a mollusc. The mollusc senses the irritant and begins to deposit minerals around it, principally calcium carbonate (aragonite). Over time this grows into the much sought after pearl. Cultured pearls are formed in molluscs through human intervention – for example, seeding with a specific irritant to begin the mineralization process. Synthetic pearls can be in the form of plastic and glass imitations, or reconstructed calcium carbonate with a colour coating.

The internal structure of pearls depends upon their origin. For example, natural seawater pearls are usually formed without a nucleus, whilst cultured seawater pearls often have a nucleus and a layer of nacre (conchiolin) 0.5-2 mm thick. Freshwater pearls can be found both with and without nuclei, but the most common variety (Chinese) have no nuclei. They are distinguished from seawater pearls by their surface characteristics (ie, lustre and patterning). Imitation pearls composed of plastic or glass can quickly be categorised by their lack of calcium content.

X-ray analysis of pearls

The optimised beam collimation provided by the mono-capillary x-ray guide tubes of the XGT-5000 instrument allows even large spherical samples such as pearls to be accurately analysed (see Figure 1). The XGT's parallel micro-beam is unaffected by the significant curvature of the pearl's surface. The elemental composition and internal structure can be quickly and clearly visualised. The XGT is thus ideally suited for non-destructive investigation of pearls to identify the possible presence of nuclei and conchiolin layers (via transmission imaging) and characterise composition (via XRF analysis).

JOBIN YVON Technology

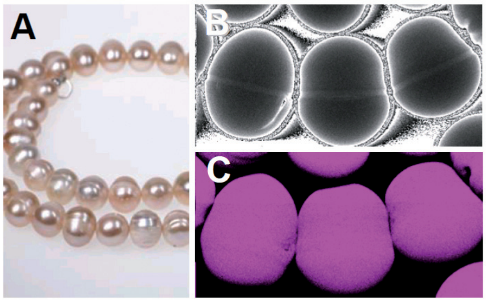


Figure 1 – (A) Chinese freshwater cultivated pearls, (B) transmission x-ray image and (C) calcium XRF image over a portion of the necklace

Since many of the imitation pearls are made from plastics, which are invisible to an XRF instrument, they can quickly be distinguished from the calcium containing minerals which would be found in natural and cultured pearls (Figure 2). It is even possible to gain insight into the complex colourants used for these imitations, as Figure 3 shows. The strong presence of bismuth is perhaps not surprising, as there are a number of bismuth species used in typical pearlescent colourants.

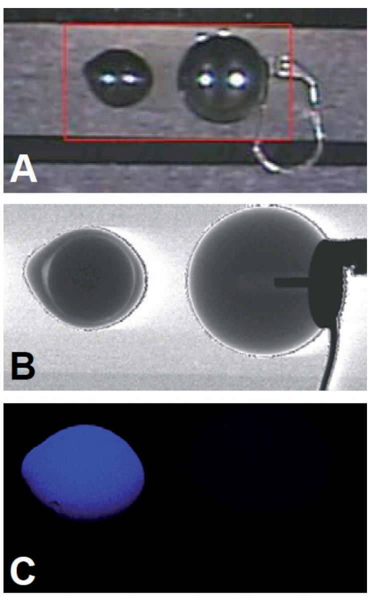


Figure 2: A) Optical image of pearls, cultured (left) and imitation (right), with mapping region shown in red, (B) transmission x-ray image, and (C) calcium XRF image.

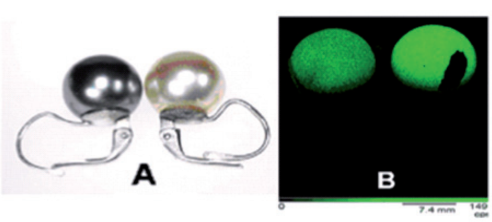


Figure 3: A) optical image of two imitation pearls, (B) bismuth XRF image

X-ray transmission images (Figure 4) of two cultured pearls show distinct internal structures (aside from the drilled hole at the centre of the Chinese example). In particular, the clearly visible ring structure in the Tahiti seawater pearl is caused by a thick membrane of conchiolin. Chinese freshwater pearls are cultured around a minute fragment of mollusc organic tissue, as a result showing no nuclei or conchiolin (nacre) layers.

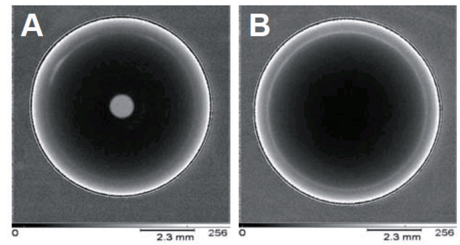


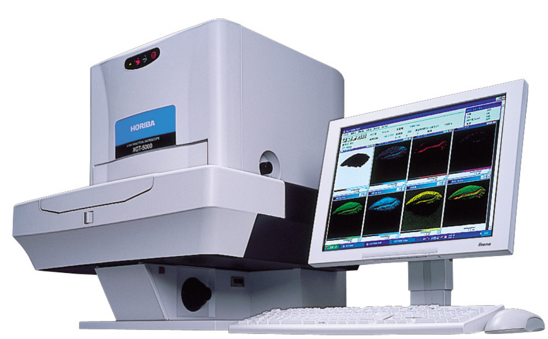
Figure 4: Ttransmission x-ra y images of two cultured pearls, (A) high quality freshwater pearl from China, and (B) seawater pearl from Tahiti.

Conclusions

The fast mapping capability of the XGT-5000, with simultaneous XRF and transmission detection, has enabled a range of pearl samples to be analysed. The elemental and structural information acquired from natural, cultivated and imitation pearls provides the researcher with useful information on the material's composition and provenance. The optimised x-ray beam collimation provided by the HORIBA x-ray guide tube technology allows even large pearls (diameter 1-2 cm) to be accurately probed for internal structure.

Acknowledgements

Data used in this application note was kindly provided by Petr Cerný of the General Directorate of Customs, Prague, and are reproduced with permission.



XGT-5000

info.sci@horiba.com
www.horiba.com/scientific

HORIBA Scientific

USA: +1 732 494 8660 **France:** +33 (0)1 64 54 13 00 **Germany:** +49 (0)89 4623 17-0
UK: +44 (0)20 8204 8142 **Italy:** +39 0 2 5760 3050 **Japan:** +81 (0)3 38618231
Spain: +34 91 490 23 34 **China:** +86 (0)10 8567 9966 **Brazil :** +55 11 5545 1540
Other Countries: +33 (0)1 64 54 13 00