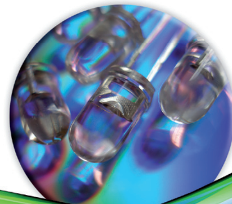
HORIBA Scientific

Application Note



Optoelectronics

XGT

XGT04

Quality control and defect analysis in the electronics industry using micro-XRF

The unrivalled 10 µm spatial resolution of the XGT-5000 combined with its high sensitivity to the transition elements makes this energy dispersive x-ray fluorescence (EDXRF) system an ideal tool for fast and accurate analysis of electronic components during the different steps of production (R&D, trouble shooting, quality control, WEEE/RoHS directive compliance).
The high intensity x-ray beam used gives much deeper penetration depths than those achieved with SEM-EDX (scanning electron microscopy with energy dispersive x-ray analysis). The penetrative analysis of XRF associated with transmitted x-ray imaging allows the non-destructive analysis of chips embedded within resin. Moreover the beam emerging from the mono-capillary x-ray guide tube (the XGT) has optimised collimation which preserves the 10 µm spatial resolution even if the sample is not in perfect focus.

Quality control of resin embedded chip

A fast mapping experiment on an electronic device allows its inner components to be analysed. Because the component is embedded in opaque resin it is completely invisible to standard optical techniques. The transmission image (Figure 1) clearly reveals the chip and the five thin wires connecting it to the contact tabs, whilst the elemental information from the XRF image identifies these wires to be composed of gold (30 µm thick).

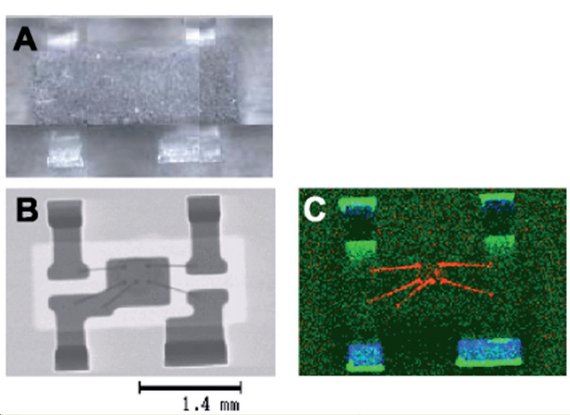


Figure 1: Analysis of resin embedded chip (A) optical image, 100x magnification, (B) transmitted x-ray image and (C) composite XRF image (Au + Ni + Sn).

Defect analysis in resin embedded chip

As with the previous example, the power of XRF to examine features otherwise invisible proved vital in understanding the failure of a small electronic component. The unique high resolution capability of the XGT-5000 allowed a microscopic join between two sections of the component to be located and identified as being caused by silver (Figure 2).

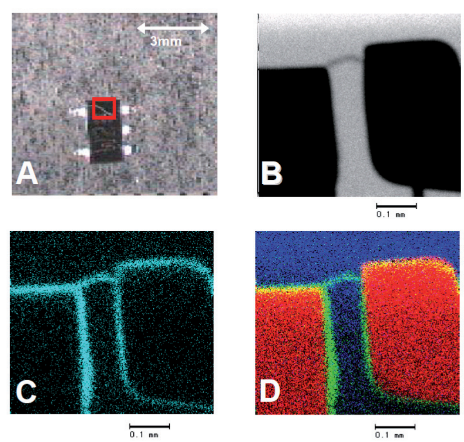


Figure 2: Analysis of defect in chip. (A) low magnification view of the chip, with the area chosen for XRF imaging shown in red, (B) transmitted x-ray image, (C) silver XRF image, and (D) composite XRF image (Cu + Ag + Br).

Failure analysis in flexible circuit board

In a flexible circuit board, the copper wiring network is sealed within a polyamide resin. Although the resin coating is relatively thin, analysis of the copper distribution by SEM-EDX is difficult, due to the very low penetration of electrons into and through the resin. However, as Figure 3 clearly shows, using the XGT-5000 for XRF analysis easily allows the Cu wiring to be visualised. The analysis reveals the presence of a steel impurity within the wiring.

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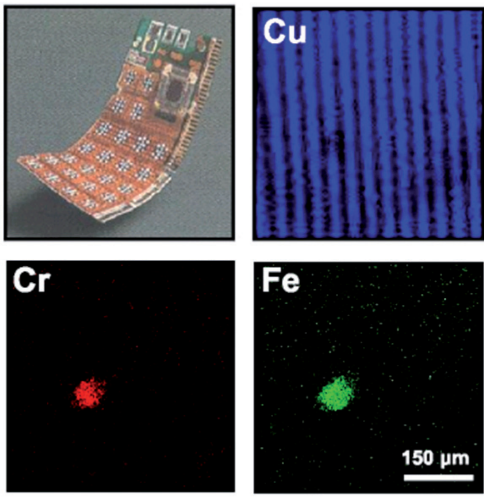


Figure 3: Flexible circuit board and XRF images showing copper wiring (Cu), and the iron (Fe) and chromium (Cr) contamination.

RoHS compliance testing in PCBs

The populated circuit board shown in Figure 4 contains components of varying height, ranging from the board itself and the wiring circuits, through to resistors and capacitors up to 3 cm in height. The optimised beam collimation of the XGT systems ensures that the ultra-narrow spot size is maintained, whether analysing the top of a capacitor, or the intricate wiring on the board. The XRF mapped image in Figure 4 clearly demonstrates this, showing the elemental analysis of the board in a region surrounded by tall components.

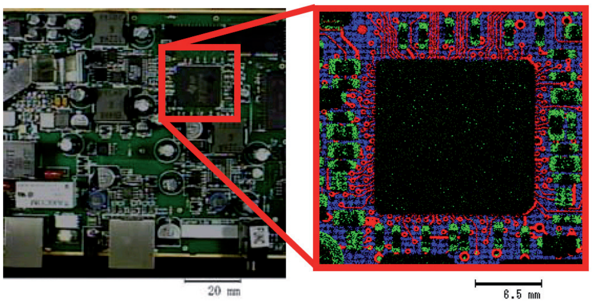


Figure 4 : Low magnification image of the circuit board, with the area chosen for XRF mapping shown in red. The corresponding composite XRF image represents Cu + Pb + Br distribution.

The mapped area shown in Figure 4 was scanned in just 500s. This fast acquisition time, combined with a straight-forward set-up procedure, makes the XGT system ideally suited for QC analysis. In this example, the detection of lead will cause the circuit to be non-compliant with the forthcoming European legislation on the Restriction of the Use of Certain Hazardous Substances (RoHS) which limits the use of Cd, Pb, Hg, CrVI and two brominated polymers. Equipped with a unique primary filter and specific software, the XGT technology is capable of detecting these substances with concentrations down to 2 ppm.

3D view of a multiple layer PCB

Since XRF analysis occurs some depth into the sample (depending on its composition), careful orientation of the PCB relative to the 45° configuration of the XGT-5000 source and detector allows x-ray fluorescence images to be acquired with 3D projection (Figure 5).

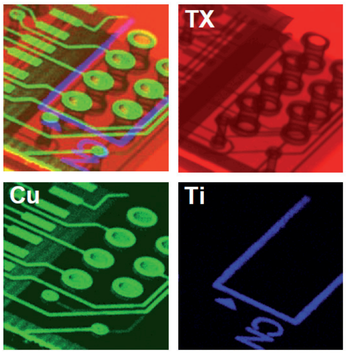


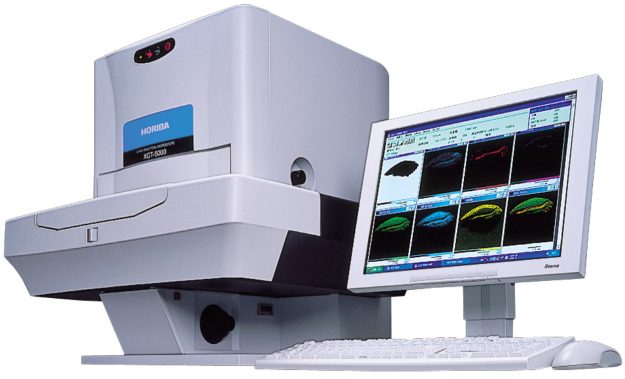
Figure 5: 3D XRF images from a PCB, showing the composite image (top left) and single colour images for transmitted x-rays (TX), copper (Cu) and titanium (Ti).

Conclusions

The XGT-5000 offers a fast, non-destructive technique for elemental mapping and transmitted x-ray analysis, and as such is a particularly useful tool for internal analysis of electronic components.

The ground breaking mono-capillary X-ray Guide Tube technology (HORIBA patent) provides high intensity beams with optimised collimation and diameters down to 10 µm, allowing even the smallest electronic features to be analysed.

Quantitative capabilities to ppm levels results in the wide use of the XGT systems in compliance testing for the forthcoming RoHS directives.



XGT-5000

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