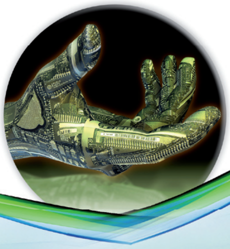


Material Science

XGT

XGT5

Fast thickness measurement of thin metal coatings by Micro-XRF

Energy dispersive x-ray fluorescence (EDXRF) is an ideal technique for fast and non-destructive elemental characterisation of materials. The XGT-5000 combines this with microscopic spatial resolution, offering unique high intensity x-ray beams with diameters ranging from 1.2 mm down to 10 µm. Accurate quantitative and qualitative analysis are possible using single point analysis, whilst elemental imaging results in detailed distribution maps for specified elements. Furthermore, an additional scintillation detector gives access to transmitted x-ray imaging, revealing internal structures, even of components embedded in resin.
Unlike SEM/EDX elemental analysis on electron microscopes, which is restricted to surfaces only, the relatively large penetration depth of x rays (typically from several µm to mm levels) allows multiple layers to be simultaneously interrogated with XRF. The resulting information can be used to calculate layer thickness, and, with the high spatial resolution of the XGT-5000, to check the homogeneity of thickness over an area (Figure 1).

Multi-layer FPM calculation

Knowing the order and element composition of the different layers equations can be set up, containing expressions for primary and secondary x-ray excitations for each element in each layer. These complex equations also include many physical and hardware fundamental parameters (eg, x-ray absorption, incident beam energy and intensity, etc). The parameters in question (eg, layer thickness and concentration) are then adjusted, and the results are compared with with the actual x-ray intensities of the sample spectrum. Using iterative processing the thickness and concentrations of each layer can be calculated.

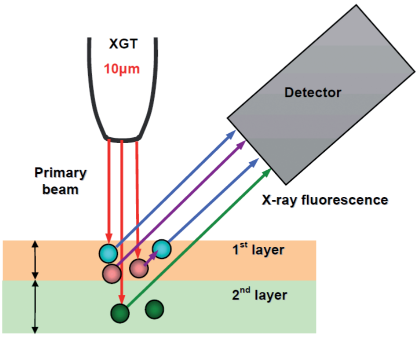


Figure 1: Schematic of the XGT5000 configuration and x-ray beam penetration.

Plating thickness analysis

A bonding pad for lead-free soldering contains gold and nickel coatings on a copper base. Without any destructive preparation of the sample, the XGT-5000 allows the thicknesses to be quickly calculated: 0.036 µm for the gold plating and 3.41 µm for the nickel plating (Figure 2).

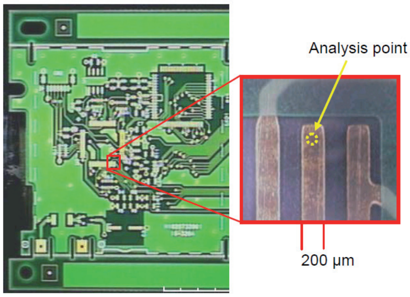


Figure 2: Images of a bonding pad on the circuit board, low resolution overview camera (left) and high resolution detailed camera (right) integrated in the XGT-5000.

The gold is expected to be in the range 0.03 to 0.05 µm. A cross section of the specimen was prepared for observation on a scanning electron microscope (Figure 3), and clearly shows the nickel plating to be 3.63 µm thick, showing excellent agreement with the micro-XRF analysis. The gold is too thin to be evaluated.

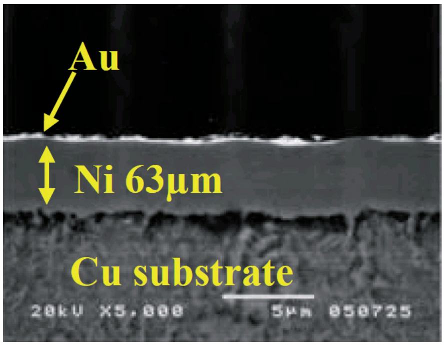


Figure 3 : SEM micrograph of cross section Au/Ni plating on Cu substrate

With the XGT-5000, the non-destructive EDXRF method of thickness calculation is combined with the unrivalled 10 µm spot size. This unique combination is applied to another pad on the board to check plating homogeneity. The measurements cover an array of points across the width of the pad (152 µm x 32 µm, 20 x 5 points, Figure 4).

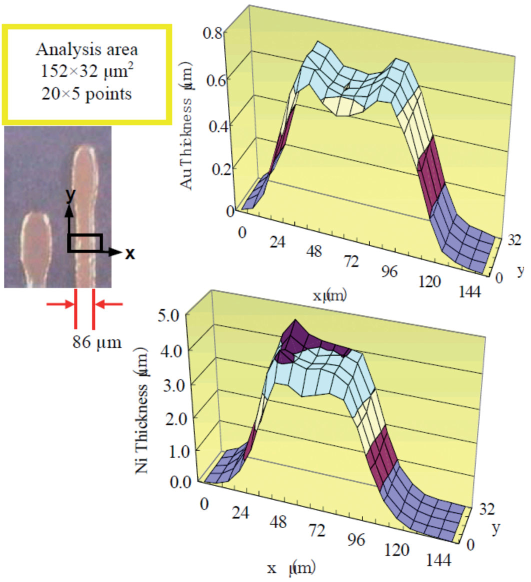


Figure 4 : Variations of gold and nickel layer thicknesses, acquired across the region shown in the optical image

Multi layer analysis

Even complex multi-layered systems can be analysed using the FPM thickness calculation module. In this packaging sample (Figure 5) a gold plating thickness of 5 nm is expected on the very restricted area where electrical contacts should be made. The 100 µm beam available on the XGT-5000 allows these microscopic areas to be discretely analysed.

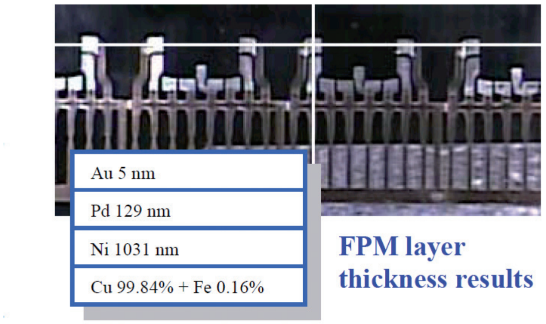
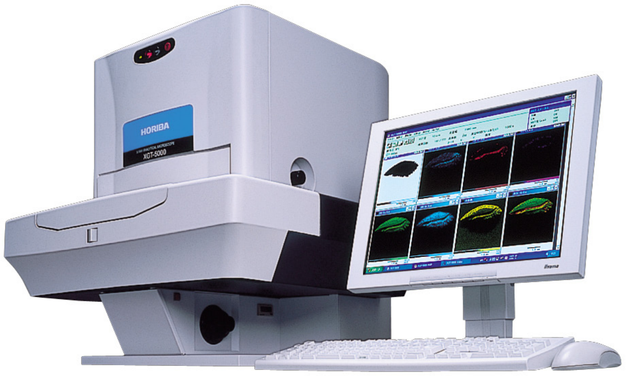


Figure 5: Series of Connectors used to package the microelectronic components. The XRF analysis point is shown by the cross hairs, and the thickness calculation results are indicated.

Conclusions

The XGT-5000 provides a fast, non-destructive method to measure the thicknesses of a multi-layered components.

The combination of XRF analysis with the unique 10 µm spot size can be used to generate accurate 3D descriptions of layered components.



XGT-5000

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

HORIBA
Scientific

Explore the future | Automotive Test Systems | Process & Environmental | Medical | Semiconductor | Scientific

HORIBA