Application Note RSMD-20101936

View on rigaku.com

Cu seed composition and thickness

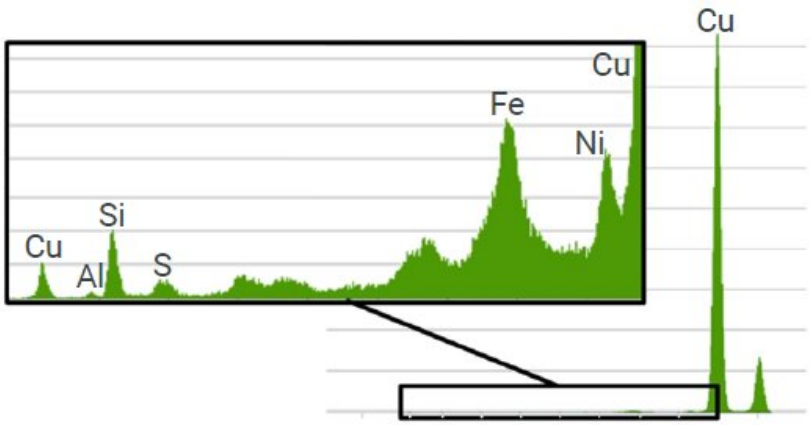
PCB panel

Introduction

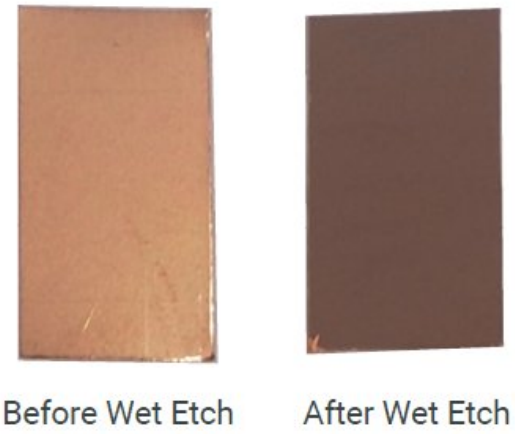
Seed copper is deposited during the PCB manufacturing process, often over other Cu layers, a process that requires accuracy in the thickness of this thin layer. Measurement of the seed layer thickness for quality assurance is available using Energy Dispersive X-ray Fluorescence (EDXRF), which overcomes the challenge of differentiating seed copper from the Cu layer beneath.

XRF Analysis

- XRF results of sample surface
- The following elements were detected: Cu, Al, Si, S, Fe, Ni, Cu
- Further analysis examples:
  - Light element detection
  - What other elements should be expected?



Acquisition time: 30 sec



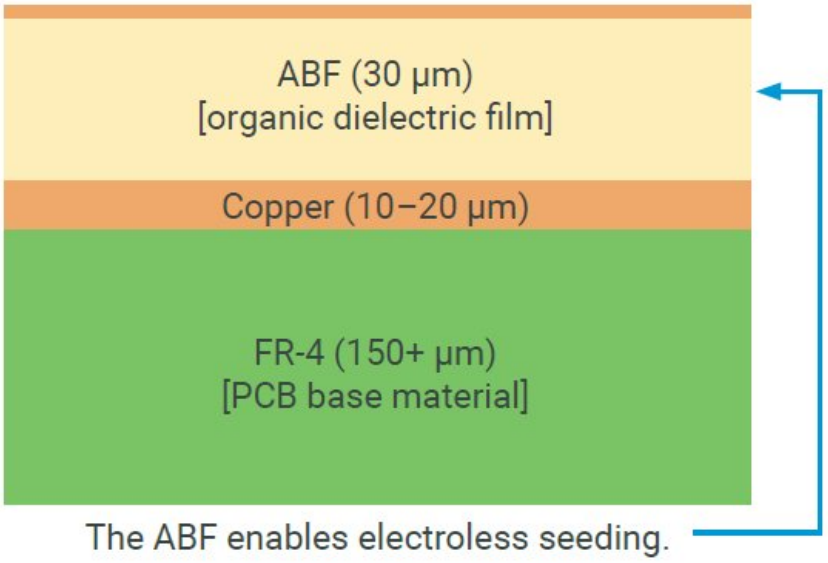
Wet etch

- Etch performed by dipping the sample (for one minute) in a solution containing:
- H_20_2 (3%)
- Citric acid
- NaCl

Measurement objective

To measure the thickness of the top, electroless-deposited Cu seed layer at several sample locations.

Electroless Cu seeding (1 µm)

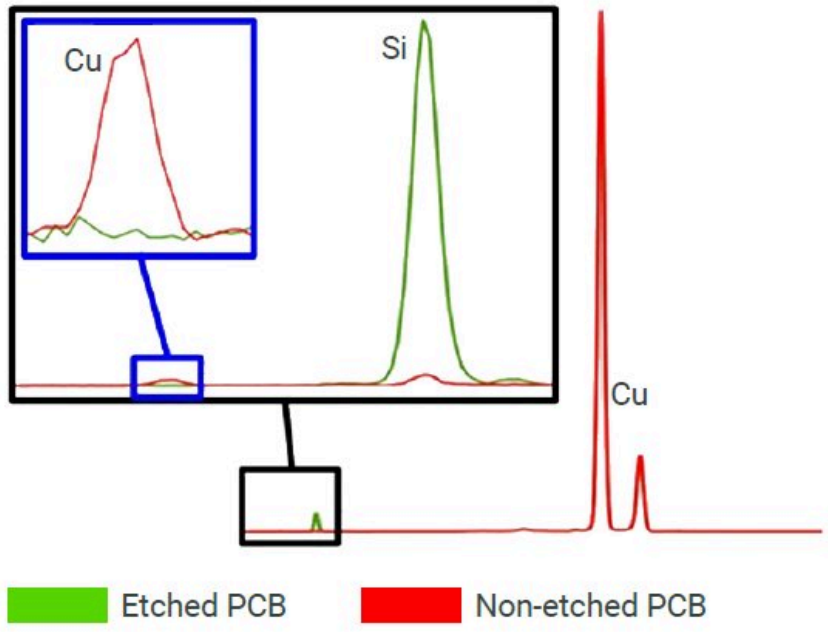


- ABF, Ajinmoto Build-up Film, is a carbon-based epoxy film developed by Ajinmoto Co.

- FR-4, flame retardant class 4, is a type of laminated substrate material used in the manufacture of printed circuit boards (PCBs).

Top Cu layer isolation

- The top Cu layer was removed from one of the samples using wet etch.
- XRF comparison was made between etch and non-etch samples.
- Cu Lα comes only from the top Cu layer.



Cu Lα saturation test

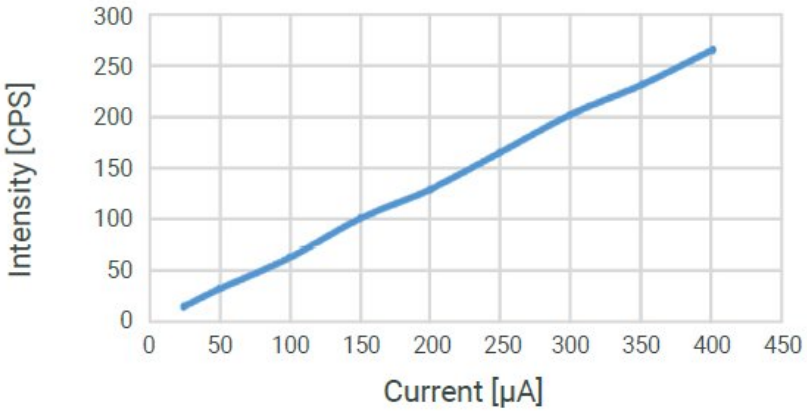
- For the top Cu layer, 1 µm is much below the saturation depth.
- Saturation in XRF is a specific depth of the layer whereby intensity no longer changes beyond this layer thickness.
- Thickness changes correlate to changes in the current.
- XRF measurement was performed at the same location using varying currents in order to determine the ideal linear section of the intensity vs. current curve.

Cu thickness sample comparison

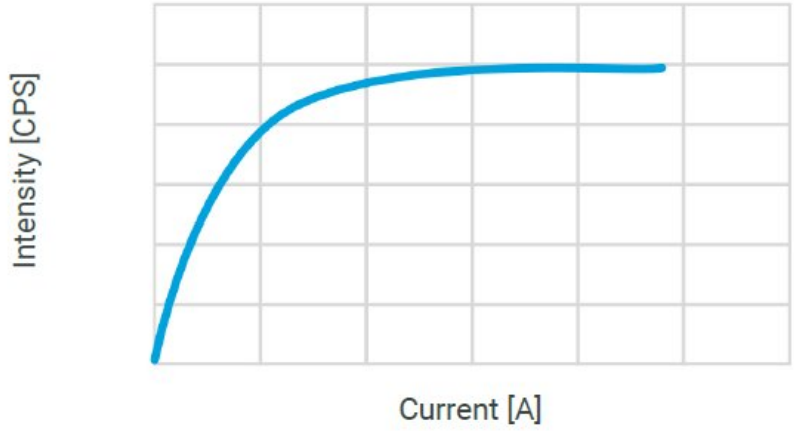
- XRF scan was performed over six points (1 mm step) on three different samples.
- Cu Lα peak intensity was compared.
- The average intensity of Samples B and C were used as reference with thickness of 1 µm.
- Sample A has significantly thinner top Cu layer than Samples B and C.

- The top Cu layer of Samples B and C has uniform thickness, unlike Sample A.

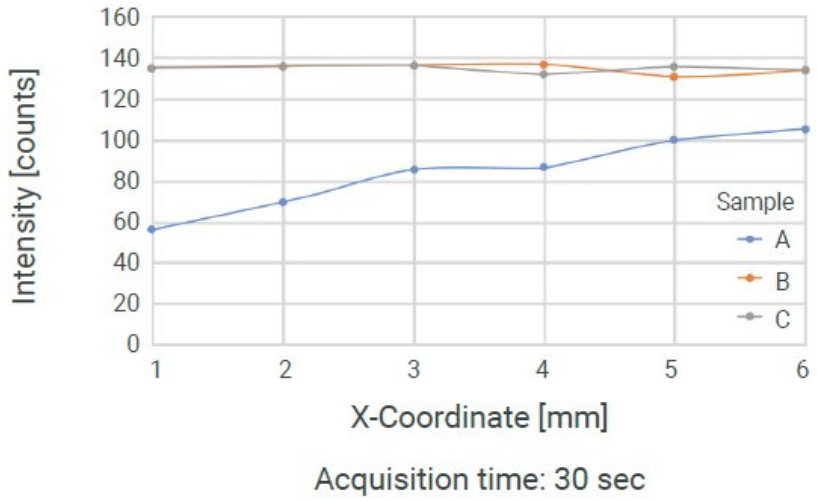
Cu intensity



Intensity vs. current



Across-wafer variation

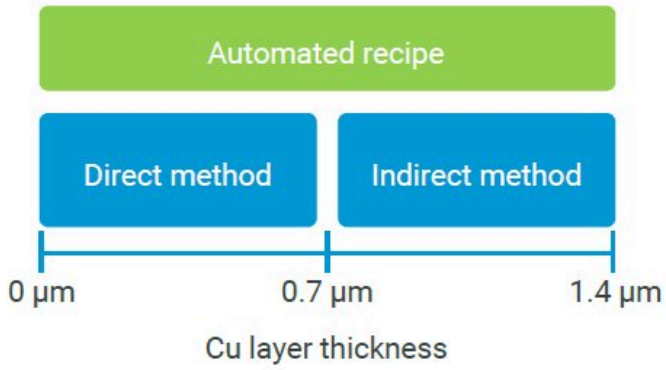


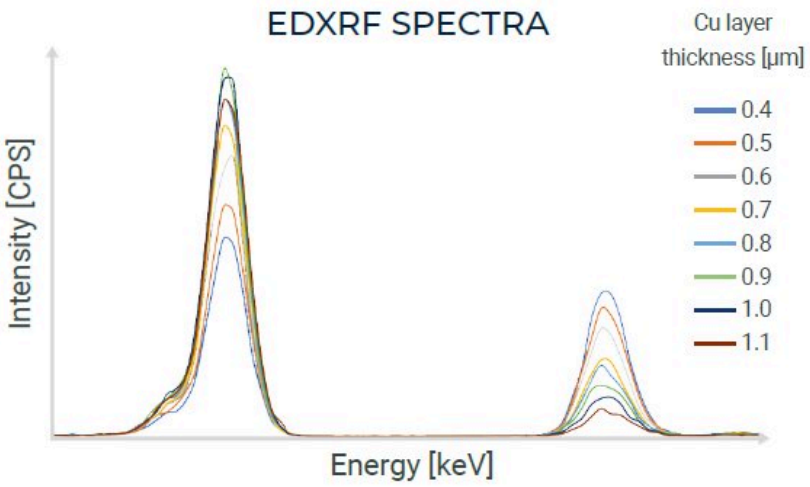
Cu layer thickness [µm]

Point	Sample A	Sample B	Sample C
1	0.42	1.00	1.00
2	0.52	1.01	1.01
3	0.64	1.01	1.01
4	0.65	1.01	0.98
5	0.74	0.97	1.01
6	0.78	0.99	0.99
Average	0.62	1.00	1.00

Cu seed thickness measurement by direct and indirect methods

- Cu layer thickness is measured by an automated algorithm using two methods.
- Direct method (0–0.7 µm) measuring the Cu Lα peak and calculating Cu layer thickness using linear regression
- Indirect method (0.7–1.4 µm) measuring the Si Kα peak and calculating Cu layer thickness using exponential regression
- Cu Lα peak intensity is saturated due to its low energy (0.93 keV), so the Cu layer thickness is measured indirectly using the Si from the ABF layer.



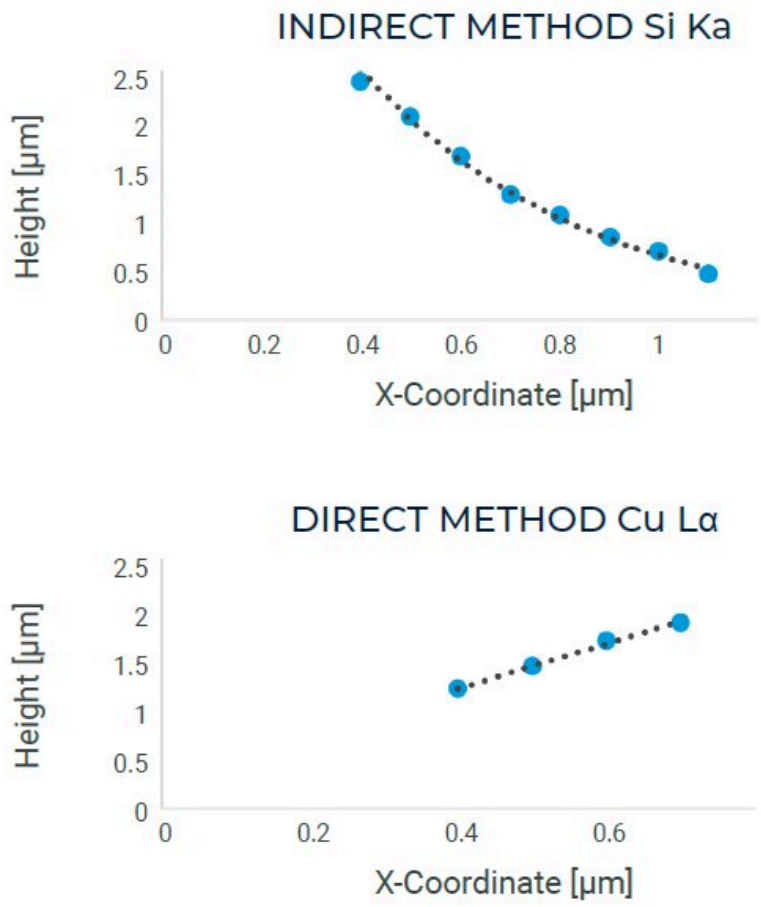


- Cu Lα and Si Lα were clearly detected by the EDXRF.
- Cu upper layer thickness can be monitored by using both peaks independently – Cu Lα or Si Kα peaks.
- Acquisition time: 12 sec

Nominal [µm]	Direct Method [µm]	Indirect Method [µm]
0.4	0.398	0.382
0.5	0.496	0.462
0.6	0.613	0.571
0.7	0.689	0.704
0.8	-	0.788
0.9	-	0.888
1.0	-	0.960
1.1	-	1.083

Regression curves

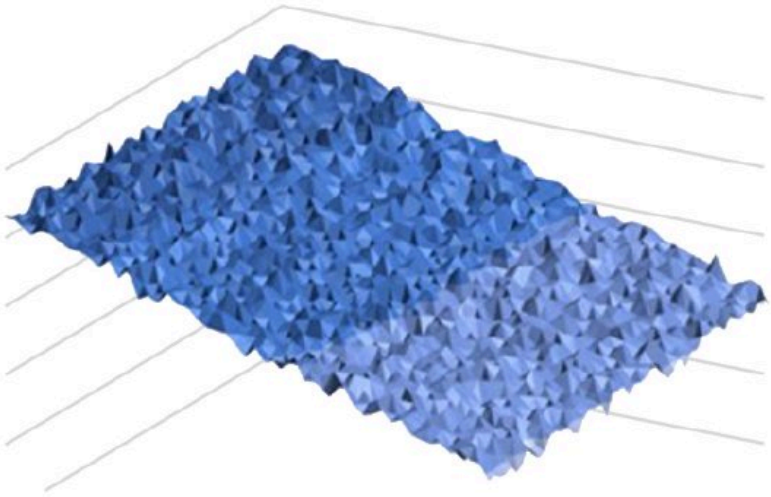
- Linear regression for the direct method
- Exponential regression for the indirect method



Roughness

- 3D scanner was used for measuring roughness by measuring surface height variations.
- Height variation up to 2 µm

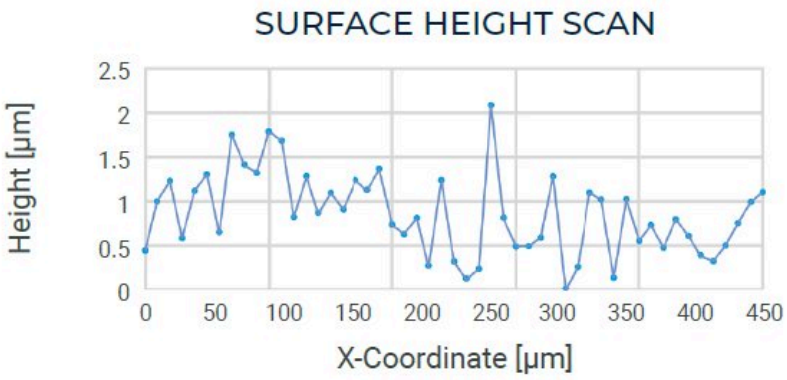
3D scan imaging

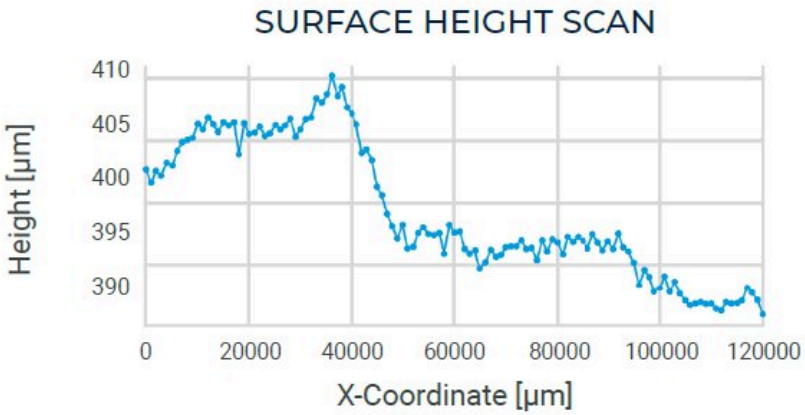


Resolution: 10 µm step
0.5 mm x 0.5 mm area

2D microscope image

Magnification: X50





Summary

- XRF is very sensitive to thickness variation up to 0.1 nm. Many elements can be analyzed, qualitatively and quantitatively.
- Top Cu layer thickness can be measured using Cu Lα peak intensity changes.
- For accurate results, standards are required.
- The 3D scanner can monitor surface roughness.

Related products

ONYX 3000

EDXRF and optical hybrid metrology tool for automated X-ray analysis, 3D scanning, and 2D microscope for film thickness and composition measurements on blanket and patterned wafers for up to 300 mm wafers