Application Brief

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SFT no.29 Measuring Ultra Thin Au Plating Using the SFT9500

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1. Forward

In recent years, advancements in miniaturization and ultra thin plating have accompanied developments in technology. In particular, the thickness of the flash plating in the gold plating process has reached the nano order. Because of the thinness of the film, the sensitivity of fluorescent X-ray measurement is insufficient for proper measurement. In this report, the SFT9500 is used to measure plating. This model employs polycapillary optics in its optical system and a high count rate semiconductor detector to ensure the control of plating thickness at the nano order, which has been difficult to measure with previous models.

2. Testing

The measurement samples were a pre-plated lead frame (Au/Pd/Ni/Cu) and a standard sample. Since three layers (Au/Pd/Ni) were measured simultaneously, the thin film FP method was used. Table 1 shows the measurement conditions for this sample and Table 2 shows data for the standard sample used for the measurements. The measurement times were 10, 30 and 60 seconds and measurements were repeated 20 times.

Table 1 – Measurement Conditions for the Au/Pd/Ni Plating

Unit:	SFT9500
Analysis Method	Thin film FP method
X-ray irradiation diameter	0.1mm
X-ray tube voltage	30kV
Tube current	1mA
Primary Filter	OFF
Au analysis line	$L\alpha$
Pd analysis line	$L\alpha$
Ni analysis line	$K\alpha$
Cu analysis line	$K\alpha$

Table 2 – Standard sample

Element	Thickness
Au	0.045 µm
Pd	0.051 µm
Ni	2.55 µm
Cu	Unlimited thickness

3. Results

The thin plated lead frame was measured at each time condition 20 times. The results are shown in Tables 3, 4, and 5.

Table 3 – Results of the 10-second Lead Frame Measurements

	Au	Pd	Ni
Mean(m)	0.0051	0.0105	0.7696
Std. Dev.	0.0011	0.0009	0.0032
Max(m)	0.0069	0.0124	0.7774
Min(m)	0.0020	0.0089	0.7629
Range(m)	0.0049	0.0035	0.0145
CV (%)	22.037	8.223	0.421

Table 4 – Results for 30-second Lead Frame Measurements

	Au	Pd	Ni
Mean(μm)	0.0052	0.0107	0.7719
Std. Dev.	0.0004	0.0005	0.0020
Max(μm)	0.0061	0.0118	0.7760
Min(μm)	0.0046	0.0099	0.7683
Range(μm)	0.0015	0.0019	0.0077
CV(%)	7.507	4.257	0.253

Table 5 – Results for 60-second Lead Frame Measurements

	Au	Pd	Ni
Mean(μm)	0.0049	0.0106	0.7706
Std. Dev.	0.0003	0.0004	0.0009
Max(μm)	0.0053	0.0112	0.7725
Min(μm)	0.0044	0.0099	0.7690
Range(μm)	0.0009	0.0013	0.0035
CV (%)	5.624	3.910	0.123

The standard foil used for standard sample registration was measured 20 times at each measurement time condition. The results are shown in Tables 6, 7, and 8.

Table 6 – Results for the 10-second Standard Sample Measurements

	Au	Pd	Ni
Mean(μm)	0.0461	0.0500	2.6145
Std. Dev.	0.0014	0.0025	0.0104
Max(μm)	0.0484	0.0544	2.6375
Min(μm)	0.0436	0.0466	2.6006
Range(μm)	0.0048	0.0078	0.0369
CV(%)	2.941	4.971	0.396

Table 7 – Results for the 30-second Standard Sample Measurements

	Au	Pd	Ni
Mean(μm)	0.0453	0.0511	2.6026
Std. Dev.	0.0008	0.0011	0.0058
Max(μm)	0.0467	0.0529	2.6126
Min(μm)	0.0440	0.0488	2.5926
Range(μm)	0.0027	0.0041	0.0200
CV(%)	1.763	2.158	0.222

Table 8 –Results for the 60-second Standard Sample Measurements

	Au	Pd	Ni
Mean(μm)	0.0451	0.0507	2.5859
Std. Dev.	0.0005	0.0010	0.0056
Max(μm)	0.0461	0.0519	2.5984
Min(μm)	0.0435	0.0481	2.5757
Range(μm)	0.0026	0.0038	0.0227
CV(%)	1.182	1.911	0.215

4. Conclusion

The SFT9500 could repeatedly measure 0.05 um of Au at measurement times as low as 10 seconds at a CV of 3 %. When the thickness reached the nano order, the 60-second time condition produced a stable measurement at a CV of between 5 and 6%. The SFT9000 series has a primary and secondary filter and measures under multiple measurement conditions. However, the SFT9500 does not use a filter so it can measure with one condition, which results in reduced measurement time.

Cautions when using the SFT9500

It has been confirmed that when a measurement sample is analyzed using the SFT9500 as in this application, the diffraction lines from Ni/Cu overlap at the position of the Au-Lα line and may affect the analysis results. This issue is due to the features of the SFT9500. It uses a light-focusing polycapillary in its optical system so its X-ray intensity is much greater than previous models and the primary filter irradiates the measurement sample from various angles so it detects minute peaks that could not be seen with previous models. Therefore, be aware of the affect of diffraction lines on measurements. The diffraction lines derive from the structure of sample and changing angles changes the intensity of the diffraction lines. Therefore, when diffraction lines have been identified (e.g. the measurement values are unusual), change the angle of the measurement sample and check the effect on the diffraction lines.

An investigation was performed regarding the influence of diffraction lines on Au plating measurements.

When Ni/Cu sample without Au plating was measured, diffraction lines appeared in the AuLα area, as shown in Figure 1. When this was converted to film thickness, a result of approximately 0.009 um was obtained as the average of the results for the 10 repeated measurements.

To remedy this problem, measure at an angle where no diffraction lines appear (Figure 2) or calculate using AuMα, where diffraction lines do not have any effect. However, AuMα is low in energy and its sensitivity is poorer than Lα so the CV value may worsen by about 2.5 times.

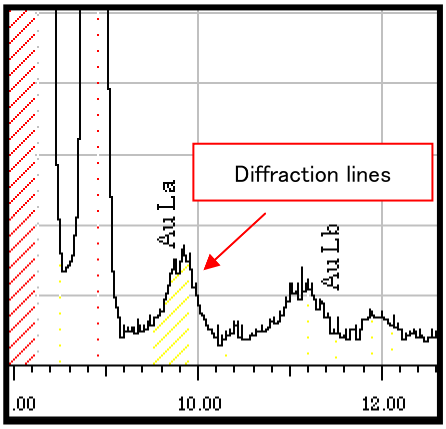

Figure 1 – Diffraction lines from Ni5μm on Cu

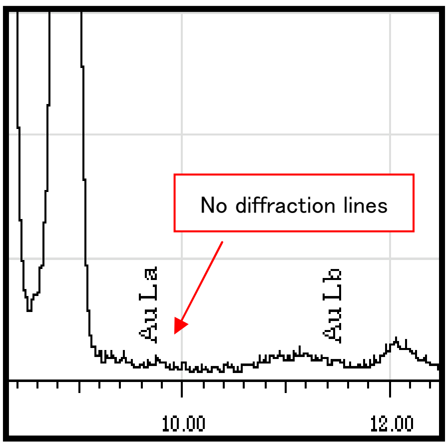

Figure 2 – No diffraction lines from Ni5μm on Cu