Application Brief

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SFT NO.4 JUL.1998 Ultra-thick Au Coating Measurement

1. Overview

Simultaneous measurement of a Au coating of 2 um in thickness or greater with the Seiko SFT series (Fluorescent X-ray Micro Analyzer) was difficult from limitations of the detector resolution and thin film calculation algorithm to the substrate Ni coating.

In addition to an improved signal to noise ratio by employment of a high resolution semi-conductor detector, the SEA5100 series machine is able to measure a substrate Ni film 5 um thick and surface Au coating (which up to now could not be measured) by an improved calculation process that applies the Fundamental Parameter (FP) Method.

This application brief reports on the SEA5120 and provides measurement samples.

2. Analysis Conditions

Figure 1 shows a comparison of resolutions of the SFT3000S detector (proportional counter) vs. the SEA5120 detector (semi-conductor). Measurement samples and conditions are listed in Table 1.

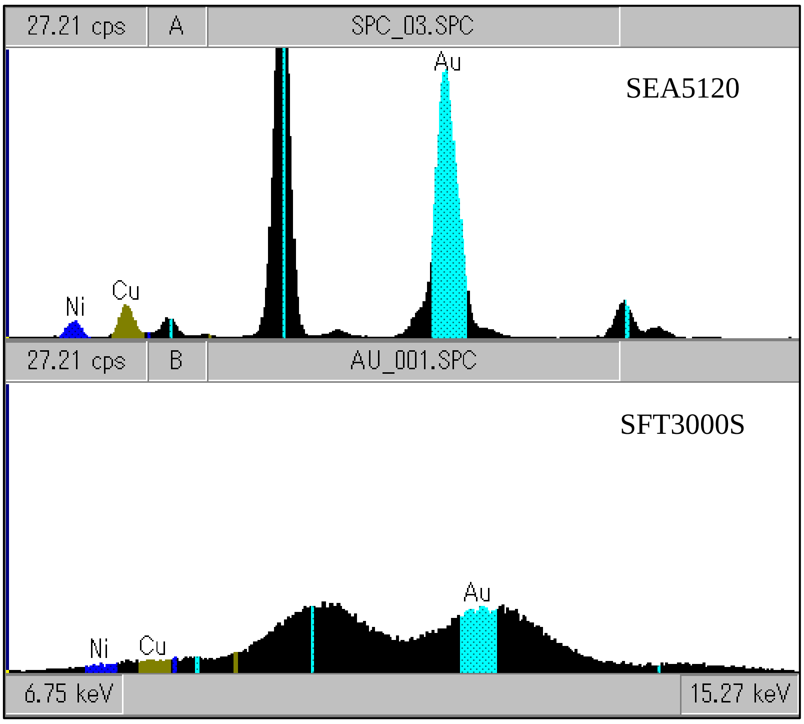


Figure 1 Difference in detector resolution

Table 1 Measurement Conditions

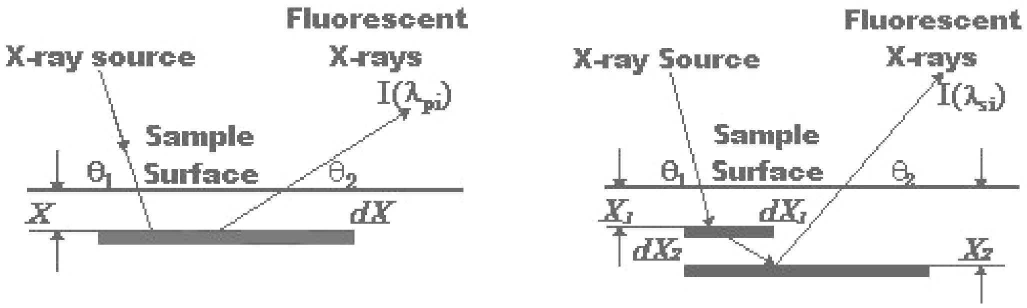
	SEA5120	SFT3000S
Collimator	0.1 mm	0.1 mm
Tube Voltage	50 kV	45 kV
Tube Current	1 mA	1 mA
Target Material	Mo	W
Measurement Time	300 seconds	300 seconds
Sample	Au(4.91um)/Ni(4.45um)/Cu	

The SEA5120 has superior resolution. This can be seen in the results by the high S/N ratio. This is clearly indicated by the Ni layer and base Cu peaks.

3. FP Method

Quantitative methods can be roughly classified into measuring standard sample of known composition and thickness or the method of creating a calibration curve from the relationship of fluorescent X-ray intensities and thickness/composition, and theoretical calculation method called the Fundamental Parameter (FP) Method. Explained herein is the thinking behind the FP method in which quantitative results can be easily obtained with fewer standard samples.

Analytical intensity is able to describe the sample composition and fundamental constant (fundamental parameter) as a function if the sample in analytically uniform. In other words, the intensity produced from a sample of any composition can be calculated from this fundamental constant.



Primary Fluorescent X-rays

Secondary Fluorescent X-rays (Excitation Effect)

Figure 2 Analytical rays generating mechanism by excitation effect

Figure 2 displays models for generating fluorescent X-rays. Fluorescent X-ray intensity and actual values theoretically analyzed and obtained from the models are in agreement. Quantitative analysis based on these facts is called FP method.

If the depth at which fluorescent X-rays are generated is infinite in terms of X-rays, then the FP method is suitable for bulk samples, and if depth is a small value (less than the critical thickness) then the FP method is suitable for thin film samples. A major characteristic of the FP method is the ability to simultaneously measure composition and thickness of thin film samples from composition analysis of bulk samples. The SEA5100 series has a bulk FP method for analyzing bulk samples and a thin film FP method for analyzing thin film samples.

4. Measurement Accuracy and Repeatability

4.1 Accuracy

Table 2 shows results of the measurement. Results are of one 300 second measurement. Measurement conditions are the same as in Table 1.

Table 2 Measurement Results

Standard Value		Au		Ni	
Au (um)	Ni (um)	Value (um)	Error (%)	Value (um)	Error (%)
1.91	2.45	1.95	+2.09	2.14	-12.7
1.91	4.45	1.94	+1.57	4.55	+2.02
1.91	9.68	2.04	+6.08	9.06	-6.40
2.84	2.45	2.91	+2.46	2.22	-9.38
2.84	4.45	2.84	0	4.45	0
2.84	9.68	3.04	+7.04	8.80	-9.09
4.91	2.45	4.68	-4.68	2.63	+7.35
4.91	4.45	4.70	-4.28	4.54	+1.79
4.91	9.68	4.67	-4.89	9.22	-4.75

Here the error is the difference between the standard value and measurement value divided by the standard value. Au: 2.84 um and Ni: 4.45 um samples were used as standard samples for FP calculations.

4.2 Repeatability

Table 3 shows the results of thirty 60 second measurements. Calculation conditions are the same as for Table 2.

Table 3 Measurement Results

Au (1.91 um)					Ni (4.45 um)				
Ave	1 σ	CV	Range	Error	Ave	1 σ	CV	Range	Error
1.95	0.013	0.648	0.05	+2.09	4.89	0.077	1.57	0.33	-9.89
Au (2.45 um)					**Ni (4.45 um)**				
Ave	1 σ	CV	Range	Error	Ave	1 σ	CV	Range	Error
2.43	0.013	0.534	0.06	-0.82	4.82	0.085	1.76	0.41	+8.31
Au (4.91 um)					**Ni (4.45 um)**				
Ave	1 σ	CV	Range	Error	Ave	1 σ	CV	Range	Error
4.70	0.039	0.837	0.17	-4.28	4.96	0.249	5.02	1.21	+11.5

5. Summary

This experiment clarifies that the surface layer can be measured at 5% error and the middle layer can be measured at 10% error when the surface layer Au has a thickness of 5 um or less, the middle layer Ni has a thickness of 10 um or less, and the base is Cu.

There are three major advantages to using the SEA5120:

1) Ability to accurately measure fluorescent X-ray intensity of Au, Ni, and Cu
2) Ability to find layer thickness' using the FP method
3) Best if using a minimum one point standard sample (One Standard Correction).