

Au/Pd/Ni/Cu Measurement

1. Overview

Accompanying recent developments of substitute solders that contain no lead, Au/Pd/Ni film is good surface treatment for solder wettability and surface preparation for the solder composition plane in lead frames and printed circuit boards. There is an increasing number of inquiries concerning measurements of a very thin Au film surface layer and middle Pd film layer.

This paper introduces three layer simultaneous measurement of Au/Pd/Ni using the thin film Fundamental Parameter Method and evaluates limitations of the measurement.

2. Instrument

Instruments used include the SFT3200S Fluorescent X-ray Coating Thickness Gauge and SEA5120 Micro XRF Element Monitor. The SFT3200S is a widely used coating thickness gauge. The SEA5120 is a fluorescent X-ray analyzer that uses a high resolution detector, but can measure coating thickness at the same micro area as the SFT3200S, and can be applied to coating thickness at 10 times the precision as before.

3. Experiment

Measurement Sample

| | Au (um) | Pd (um) | Ni (um) |
|----|---------|---------|---------|
| #1 | 0.005 | 0.1 | 5.0 |
| #2 | 0.01 | 0.2 | 5.0 |
| #3 | 0.01 | 0.5 | 5.0 |
| #4 | 0.05 | 0.2 | 5.0 |
| #5 | 0.05 | 0.5 | 5.0 |

This table shows that a sample was used with all layers at thin film levels.

Measurement Conditions

| SFT3200S | | | | | SEA5120 | | | | |
|--------------|---|--------|----|-----|--------------|-------------|--------|----|----|
| | Au | Pd | Ni | Cu | | Au | Pd | Ni | Cu |
| Collimator | | 0.1 mm | | | Collimator | | 0.1 mm | | |
| Target | | W | | | Target | | Mo | | |
| Prim. filter | | ON | | | Prim. filter | | n/a | | |
| 2nd filter | OFF | OFF | ON | OFF | 2nd filter | | n/a | | |
| Time | Secondary OFF: 50 seconds Secondary ON: 50 seconds | | | | Time | 100 seconds | | | |

Quantitative Conditions

In the case of both instruments, correction was performed using the following standard samples and the FP Method. We chose not to use Cu in the calculation as a FP calculation condition. We also inactivated background removal.

| SFT3200S | | | | | SEA5120 | | | | |
|-----------------|-------|------|------|------|----------------|-------|------|------|------|
| Stand | Au | Pd | Ni | Cu | Stand | Au | Pd | Ni | Cu |
| #1 | Inf. | | | | #1 | 0.045 | 0.25 | 5.22 | Inf. |
| #2 | | Inf. | | | | | | | |
| #3 | | | Inf. | | | | | | |
| #4 | | | | Inf. | | | | | |
| #5 | 0.045 | 0.25 | 5.22 | Inf | | | | | |

Measurement Method

Measurement of each sample was repeated 10 times and the results compared.

4. Results

SFT3200S Measurement Results

| | | Ave. | R | Sigma | Max. | Min. |
|----|----|-------|-------|-------|-------|-------|
| #1 | Au | 0.006 | 0.001 | 0.000 | 0.006 | 0.004 |
| | Pd | 0.036 | 0.003 | 0.001 | 0.038 | 0.035 |
| | Ni | 0.622 | 0.046 | 0.013 | 0.645 | 0.599 |
| #2 | Au | 0.017 | 0.004 | 0.001 | 0.019 | 0.015 |
| | Pd | 0.194 | 0.009 | 0.003 | 0.199 | 0.190 |
| | Ni | 5.479 | 0.516 | 0.139 | 5.729 | 5.213 |
| #3 | Au | 0.064 | 0.015 | 0.005 | 0.073 | 0.058 |
| | Pd | 0.178 | 0.030 | 0.010 | 0.193 | 0.163 |
| | Ni | 5.816 | 0.718 | 0.228 | 6.318 | 5.600 |
| #4 | Au | 0.017 | 0.012 | 0.004 | 0.025 | 0.013 |
| | Pd | 0.452 | 0.036 | 0.011 | 0.469 | 0.433 |
| | Ni | 5.705 | 0.866 | 0.296 | 6.126 | 5.260 |
| #5 | Au | 0.073 | 0.013 | 0.004 | 0.080 | 0.067 |
| | Pd | 0.454 | 0.061 | 0.018 | 0.489 | 0.428 |
| | Ni | 6.118 | 0.585 | 0.196 | 6.391 | 5.806 |

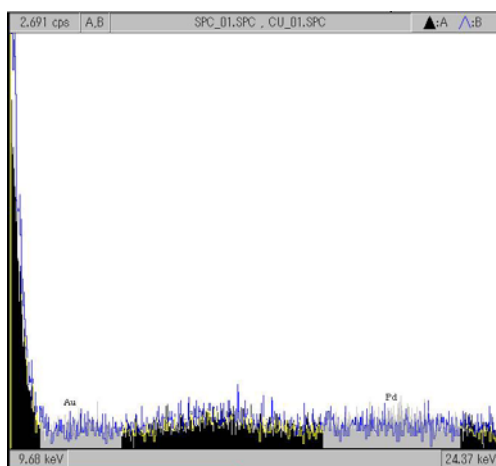
When measuring sample #1 the SEA5120 was used to perform known sample correction with the same sample.

SEA5120 Measurement Results

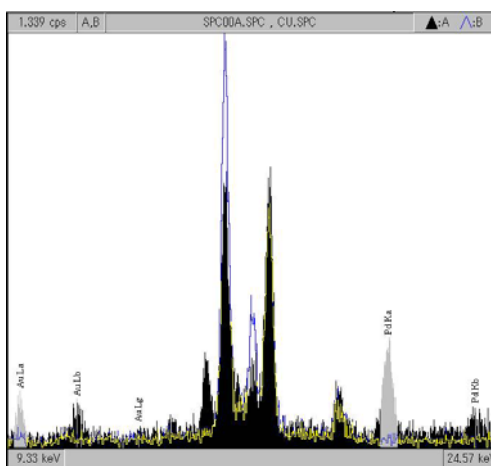
| | | Ave. | R | Sigma | Max. | Min. |
|----|----|-------|-------|-------|-------|-------|
| #1 | Au | 0.004 | 0.001 | 0.000 | 0.004 | 0.003 |
| | Pd | 0.025 | 0.011 | 0.003 | 0.030 | 0.019 |
| | Ni | 0.645 | 0.021 | 0.006 | 0.656 | 0.635 |
| #2 | Au | 0.012 | 0.002 | 0.001 | 0.013 | 0.011 |
| | Pd | 0.199 | 0.031 | 0.010 | 0.217 | 0.186 |
| | Ni | 5.347 | 0.208 | 0.075 | 5.439 | 5.231 |
| #3 | Au | 0.062 | 0.005 | 0.001 | 0.064 | 0.059 |
| | Pd | 0.181 | 0.027 | 0.008 | 0.190 | 0.169 |
| | Ni | 5.817 | 0.177 | 0.052 | 5.879 | 5.720 |
| #4 | Au | 0.011 | 0.003 | 0.001 | 0.012 | 0.009 |
| | Pd | 0.470 | 0.042 | 0.013 | 0.490 | 0.448 |
| | Ni | 5.663 | 0.247 | 0.095 | 5.785 | 5.538 |
| #5 | Au | 0.069 | 0.004 | 0.001 | 0.072 | 0.006 |
| | Pd | 0.460 | 0.024 | 0.009 | 0.470 | 0.446 |
| | Ni | 6.083 | 0.400 | 0.114 | 6.332 | 5.932 |

Difference between SFT3200S and SEA5120

Displayed below is a comparison of SFT3200S and SEA5120 spectra. Both instruments measure the above-listed sample #1. Differences in the detector resolution and peak background ratio confirm that detection sensitivity of the SEA5120 is higher than the SFT3200S



SFT3200S



SEA5120

SFT3200S Measurement Limits

Listed below are measurement limits estimated from the detection peak and background. In this case, measurement limits are 1 x the statistical deviation of the background.

Au measurement: 0.03 um

Pd measurement: 0.07 um

SEA5120 Measurement Limits

Listed below are measurement limits estimated from the detection peak and background.

Au measurement: 0.003 um

Pd measurement: 0.007 um

5. Summary

We can see from these results that the SFT3200S can measure thickness at or below the measurement limit. However, as the spectrum makes clear, Au and Pd are not detected but appear as noise. In other words, noise in the signal is obvious and does not qualify as a known standard sample. In measurements at or below detection limits, this appears in the SEA5120 as a difference of average.