APPLICATION NOTE – 017A

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X-STRATA920 AN-SDD017A

Analysis of tin coatings

INTRODUCTION

Tin is a versatile, low-melting point, non-toxic metal possessing valuable physical properties. Tin alloys readily with most other metals, and because it reacts chemically as an acid or base in nature, tin forms many useful inorganic and organic chemical compounds.

The largest use of tin electrodeposits is the production of tin plate at steel mills, primarily for use as food preservation containers. A thin tin coating protects the steel inside a tin can as long as an oxygen-free environment is produced. The second largest use of tin electrodeposits is in the electronics industry where many surfaces requiring good solderability, corrosion and tarnish resistance are coated. Electrodeposited tin is also used on food handling equipment as bearing surfaces.

Electrodeposition of tin-lead alloys is used to protect steel against corrosion, serve as etch-resistant, and facilitate soldering. The composition of the alloy varies with the application. Tin-lead deposits which usually contain 4 to 15% tin are used as corrosion resistant, protective coatings for steel. Automotive crankshaft bearings are plated with tin-lead or tin-lead-copper alloys containing 7-10% tin. Alloys containing 55 to 65% or 85 to 100% tin are plated onto printed circuit boards or copper wire for soldering or etch resistance. Because the use of lead is restricted in many areas, tin-lead solder is often replaced by tin-bismuth alloys.

To guarantee the good functionality of the plated components, platers need to ensure a consistent tin thickness. The X-Strata920 offers rapid and accurate, non-destructive analysis of tin coatings with high degree of confidence, with minimal or no sample preparation needed. The system is extremely easy to operate by non-technical staff. Its robust and rugged design is well suited for the most challenging industrial conditions.

Hitachi's family of bench-top EDXRF analysers have been employed in the field for over forty years and have served as the choice solution for tin coating thickness measurements.

X-STRATA920

Hitachi's X-Strata920 fitted with a high-resolution silicon drift detector (SDD) is a high performance, compact, rugged and reliable quality control analyser for simple, rapid coating thickness and composition analysis. Measurements can be made according to international test methods ISO 3497 and ASTM B568.

The X-Strata920 uses the non-destructive analytical technique of energy dispersive X-ray fluorescence (EDXRF) to generate an X-ray spectrum of the sample. This elemental X-ray spectrum is processed using the supplied Fundamental Parameters (FP) or empirical software to produce coating thickness or composition values.

The X-Strata920 comes in a range of chamber and base configurations to accommodate samples of different shapes and sizes. All chamber configurations are slotted for quick loading of flat or thin samples such as circuit boards and

wire. A laser focus ensures reproducible sample placement to get consistent results from any operator. The optional motorised sample stage makes it easy to automatically measure multiple samples or multiple features on a single sample, or perform scans to get a representative analysis on uneven surfaces. Collimators are user-selectable to ensure the best fit and performance on parts of all sizes.

INTUITIVE SMARTLINK SOFTWARE MAXIMIZES USER PRODUCTIVITY TO ENSURE CONSISTENT PROCESS AND PRODUCT QUALITY

All instrument functions are driven by Hitachi's SmartLink software program which is a highly intuitive, Microsoft Windows 10 compatible analytical and user interface package. Minimum staff training is required, and the simple user interface enables users at all levels to generate reliable data.

- View the sample and measurement location with clarity.
- Configure results to display high/low indicators for rapid evaluation.
- Export results to a spreadsheet program.
- Create automatic programs to measure multiple features or samples.
- Add versatility to the instrument by selecting materials and solution analysis software options.

PERFORMANCE AND RESULTS

Typical performance for common, representative applications is shown in the tables below. The precision was calculated from 30 repeat measurements. Precision is influenced by measurement time, collimator size, elements present and thickness range. In some cases the error can be reduced by optimizing the calibration range for specific applications.

Typical applications

Top Layer	Second Layer	Substrate
Sn		Cu
Sn	Ni	Cu
Sn	Cu	Al
SnPb		Cu, Brass, Bronze
SnPb	Ni	Cu, Brass, Bronze
SnBi		Cu, Brass, Bronze

Typical performance for a single-layer application, Sn/Cu using a circular collimator with a diameter of 0.3 mm (12 mil)

Analyte	Tested range	Standard error	Precision (2σ)
Sn	0.46-50 µm (18-2024 µin)	0.025 µm (1 µin) or 5% relative whichever is greater	0.24 µm @ 8.4 µm (9.7 µin @ 334 µin)

Typical performance for a single-layer application, Sn/Cu using a circular collimator with a diameter of 0.3 mm (12 mil)

Analyte	Tested range	Standard error	Precision (2σ)
Sn	0.46 - 5.16 µm (18 - 203 µin)	0.025 µm (1 µin) or 5% relative whichever is greater	0.03 µm @ 1.2 µm (1.2 µin @ 46 µin)

Note: Use parameters optimized for thin tin plating, for example when measuring immersion tin for IPC-4554

Typical performance for a dual-layer application, Sn/Ni/Cu using a circular collimator with a diameter of 0.3 mm (12 mil)

Analyte	Tested range	Standard error	Precision (2σ)
Sn	0.46-5 µm (18-200 µin)	0.025 µm (1 µin) or 5% relative whichever is greater	0.11 µm @ 2.1 µm (4 µin @ 86 µin)
Ni	0.43-15 µm (17-617 µin)	10% relative	0.44 µm @ 4.5 µm (17 µin @ 180 µin)

Typical performance for an alloy-layer application, SnPb/Cu using a circular collimator with a diameter of 0.3 mm (12 mil)

Analyte	Tested range	Standard error	Precision (2σ)
SnPb	2.7-25 µm (108-1023 µin)	0.025 µm (1 µin) or 5% relative whichever is greater	0.12 µm @ 2.7 µm (4.6 µin @ 108 µin)
Pb	10-40% Pb	2% relative for composition	0.44% Pb @ 10% Pb

Typical performance for an alloy-layer application, SnBi/Cu using a circular collimator with a diameter of 0.3 mm (12 mil)

Analyte	Tested range	Standard error	Precision (2σ)
SnBi	1.75 - 19.99 µm (69 - 787 µin)	0.025 µm (1 µin) or 5% relative whichever is greater	0.21 µm @ 6.09 µm (8.3 µin @ 240 µin)
Bi	3-11 % Bi	~15% relative for composition	0.24% Bi @ 3.4% Bi

SUMMARY

The X-Strata920 reliably offers precise analysis of tin coatings. Using Hitachi's traceable calibration standards, routine production samples can be simply and quickly measured by any level of operator. Results appear in seconds, allowing near-instantaneous optimisation of the production process.

Over 1,000 applications have been optimized for Hitachi's coatings analysers. For information about additional applications please contact our experts at contact@hitachi-hightech-as.com.

When a single micron can make the difference, depend on Hitachi's coatings analysers

Visit **www.hitachi-hightech.com/hha** for more information.

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