DeLooperAnalytical B.V.
industrial analysis instruments & services

Application note #2: Coating thickness measurements

Background

Coating, or plating, is the deposition of a metal on an object's surface (usually also made of metal) to give this object specific properties: coatings can be decorative, prevent corrosion, improve solderability, increase hardness, reduce friction and wear, and more.

To ensure that the thickness of the coating applied is sufficient to give parts and components the desired properties, without wasting material by applying too thick a layer, plating companies need to control their process and the final products. The requirement for a rapid, simple analysis (carried out by non-laboratory staff) on site makes field-portable energy-dispersive X-ray fluorescence (EDXRF) spectrometry the ideal analytical technique.

Instrumentation

The requirement for a rapid, simple analysis (carried out by non-laboratory staff) on site makes field-portable energy-dispersive X-ray fluorescence (EDXRF) spectrometry the ideal analytical technique for process control. XRF is a widely used analytical technique for the determination of layer thickness. It provides reliable and rapid analysis (results are available in seconds).

Sample preparation and measurements

There is no sample preparation required. The user simply places the nose of the analyser on the part to be measured, and presses the trigger to start the analysis. Initial results are displayed on the analyser's large (4.3") integrated touchscreen within seconds. A typical analysis time for a layer thickness measurement is 10-20 seconds (depending on the type of coating and substrate).

Performance and results

A simple empirical calibration was created for each application shown below, by measuring 6-8 samples with known coating thickness and 1 pure sample made of the coating material to establish the relationship between coating thickness and X-ray signal. Each sample was measured for 20 seconds.

The tables below show the accuracy and precision for a series of coatings applications carried out on the X-MET8000 using reference standards. The X-MET's precision was derived from 5 repeat analyses of each sample.

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Cr over Fe		
Known thickness	**Average thickness**	**Precision (95% confidence)**
5.3µm (210µin)	5.3µm (210µin)	0.02µm (0.8µin)
7.9µm (311µin)	7.8µm (307µin)	0.05µm (2.0µin)
12.4µm (487µin)	12.4µm (487µin)	0.07µm (2.8µin)

Ni over Fe		
Known thickness	**Average thickness**	**Precision (95% confidence)**
2.7µm (95µin)	2.6µm (102µin)	0.02µm (0.7µin)
10.3µm (407µin)	10.5µm (414µin)	0.10µm (3.9µin)
19.9µm (782µin)	19.9µm (783µin)	0.24µm (9.5µin)

Zn over Fe		
Known thickness	**Average thickness**	**Precision (95% confidence)**
3.0µm (120µin)	2.9µm (114µin)	0.02µm (0.6µin)
14.6µm (574µin)	14.9µm (588µin)	0.05µm (2.0µin)
19.2µm (756µin)	19.2µm (754µin)	0.13µm (5.0µin)

Ag over Cu		
Known thickness	**Average thickness**	**Precision (95% confidence)**
7.5µm (294µin)	7.4µm (290µin)	0.04µm (1.8µin)
12.1µm (477µin)	12.1µm (477µin)	0.10µm (3.8µin)
28.6µm (1,125µin)	28.9µm (1,138µin)	0.13µm (5.2µin)

Sn over Cu		
Known thickness	**Average thickness**	**Precision (95% confidence)**
4.8µm (189µin)	4.7µm (184µin)	0.07µm (2.6µin)
16.7µm (659µin)	16.6µm (655µin)	0.12µm (4.9µin)
27.3µm (1,075µin)	28.3µm (1,114µin)	0.32µm (12.7µin)

Note: the difference in µin values for the same µm value is due to additional decimal places being used for the calculation of averages and precision.

The maximum thickness that can be measured depends on the material and the analyser's components geometry (angles and distances between X-ray tube, sample surface and detector). Examples of maximum measurable thicknesses for the X-MET8000 Series are:

Coating	Substrate	Maximum coating thickness (µm)
Ag	Cu	50
Sn	Cu	50
Zn	Fe	35
Ni	Fe	20
Cr	Fe	15

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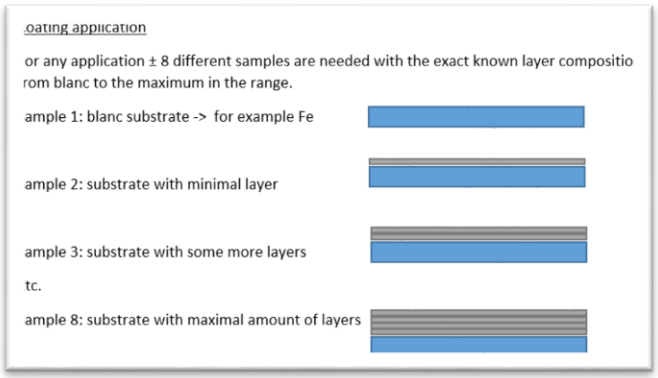
Standard calibration package

The following standard calibration package are available for the X-MET.

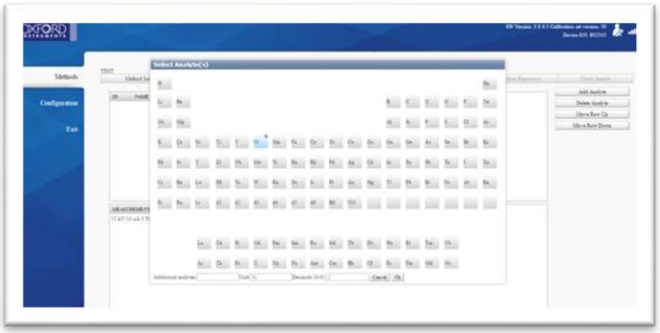
- Zn coating on Fe substrate (0-20 µm)
- Ni coating on Fe substrate (0-20 µm)
- Cr coating on Fe substrate (0-15 µm)
- Ag coating on Cu substrate (0-50 µm)
- Sn coating on Cu substrate (0-30 µm)



Customised calibration package

It is also possible to develop a customised calibration for the X-MET. Examples of this type of calibrations are:

- NiP alloy on steel substrates for determination of P content (3.5 – 11.1 wt%) and NiP coating thickness (5 – 22.4 µm)
- ZnNi coatings ((typically 10-15% Ni and 90-85% Zn) on steel. The Ni content in ZnNi is wt% 3-18 and ZnNi coating thickness 2 – 22 µm
- Cr on steel substrates 30 – 450 mg/m^2
- P traces in Zn coating on steel (P in mg/m^2)
- Ti coating on Fibre (0 -3000 ppm)
- Cr and Zn layers on foils (Cr 2.5 – 9 mg/m^2 and Zn 0 – 520 mg/m^2)
- Zn coating on Fe substrate (0-50 µm) customised



Any other customised calibration can be developed. Please use the link on the website to inform about the possibilities.

http://www.delooperanalytical.com/en/application-request/

Automatic coating analyser

It is possible to use the X-MET as an automatic coating analyser. The X-met will be integrated to an production line. The X-API (X-MET Application Programming Interface) provides remote control to the analyser and send over data to a server.

These kind of analysers are always custom made. How to get started:

1. A coating application will be added to the X-MET
2. The requirements for the automatic system need to be defined
3. Developing full solution, including the engineering and software architecture required to integrate the X-MET into the process system

More information: Please contact our sales department for a custom made solution.

sales@delooperanalytical.com

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Summary

Once calibrated, Hitachi High-Tech Analytical Science Instruments Instruments' X-MET8000 provides accurate and repeatable layer thickness analysis for a wide variety of applications.

The X-MET's ease of use and ruggedness make it an ideal tool on the shop floor for the incoming inspection of parts or components, as well as for process and quality control.

The versatility of the calibration software also enables the analysis of plating solutions (single and multi-elements), ensuring the rapid monitoring of the plating baths composition. With results being available on the X-MET's large integrated screen in seconds, decisions to accept/reject a part or modify the plating process can be made on the spot, maximising productivity and savings costs.

Contact

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