Advice & Counsel

Frank Altmayer, MSF, AESF Fellow
AESF Technical Director
Scientific Control Labs, Inc.
3158 Kolin Ave.
Chicago, IL 60623-4889
E-mail: faltmayer@sclweb.com

In the Thick of Things

Measuring Plating Thickness Has Many Variables

Dear Advice & Counsel,

I have worked at a captive plating facility for several years. We plate copper-nickel-chromium over die castings and steel parts. I am in charge of the laboratory, and many times I have wished the ability to cut across a defect and look through a microscope to find out if a problem is related to a base metal defect.

I also would like the ability to measure the thickness of individual layers of plating.

I've never done it, but I know there is a "spot test" for estimating decorative chromium plating thickness. Can you provide guidance?

Signed,
Mannie Microns

Dear Mr. Microns,

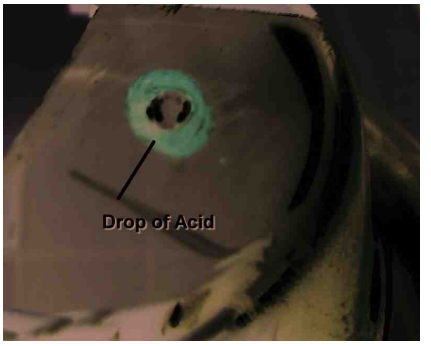
Answering your questions may take several month's worth of *P&SF*, but we will give it a try.

Addressing your last question first—measuring decorative chromium plating thickness with a spot test is relatively easy, but you need to be aware that it will only give you an estimate, and typically is only useful when the chromium thickness is below 0.000020 in. (0.5 microns). All you need is:

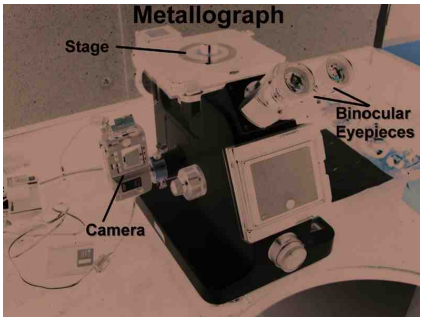
- Some alcohol
- A paper towel
- A grease pencil
- An eye dropper
- A few drops of concentrated hydrochloric acid
- A stopwatch (optional)

Note: I will assume you know how to handle the acid safely (read the MSDS and follow all instructions).

1. Clean the test area with a paper towel soaked in any type of alcohol.
2. With the grease pencil, make a small (1/4 in. diameter) circle, making sure you use enough grease pencil to create a thick waxy wall. This circle will act as a mini-tank to hold the acid, so you don't want it to leak. Use plenty of grease pencil, but be sure that the inside of the circle stays clean.
3. With the eye dropper, place a very small drop of acid inside the grease circle.
4. Wait for the acid to begin reacting with the chromium by gassing. As soon as gassing starts, start the stop watch, or count "1 Mississippi, 2 Mississippi," etc.
5. When the gassing stops, stop counting.
6. Each second of reaction represents about 0.000001 in. (0.025 microns).
7. You should repeat the test at least three times to get a good average.



If the thickness is over 0.000020 in. (0.5 microns), you are better off using a more sophisticated technique, such as a coulometric device or XRF.

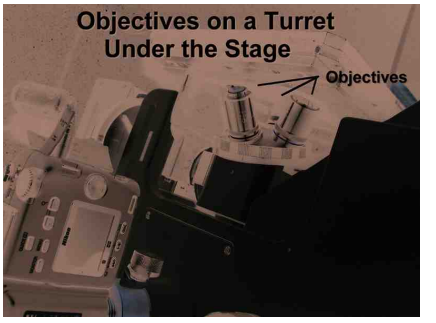


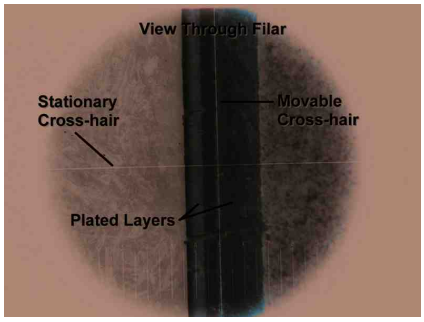
Now for the more complicated question. Micro-sectioning requires a significant investment in equipment and operator skill. The equipment is the easy part; the operator skill is best obtained by working alongside someone who has the ability.

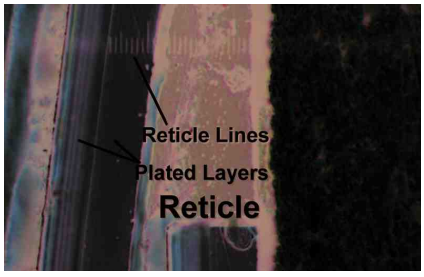
Equipment

You will need to invest in a high quality metallurgical microscope. The scope should have:

1. An easy-to-access stage (where what you are looking at goes).
2. Binocular eye pieces (you'll go blind looking in only one eyepiece all the time—just kidding).
3. Objectives for 100X, 400X and 1000X. Additional objectives are desirable, but most of your measurements will be with the 400X objective. The 1000X objective is good for looking at very tiny defects in great detail. There are objectives that allow for more than







1000X magnification, but this usually is just "empty" magnification with little additional resolution.

4. A calibrated reticle and/or a calibrated filar. These are used to measure the thickness one sees with the microscope. The reticle is suitable for measuring thicknesses above 0.0001 in., while the filar is used to measure thicknesses from 0.00002 in. to 0.0002 in.

Be aware that ASTM does not recommend using microscopic cross sections for measuring thicknesses below 0.00005 in. My personal experience is that with enough diligence and work, you can readily measure down to about 0.00002 in. with reasonable accuracy and precision.

The reticle typically produces a view with "hash-marks" going across your field of vision. To measure a thickness, all you need to do is line up the hash-marks with one side of the plated deposit and then count the number of hash-marks. You multiply the number of hash-marks against a factor obtained when the reticle was calibrated against the stage micrometer. This gives you the thickness.

A filar is typically built into an eyepiece. When you put it into the microscope and look into it, you will see what looks like a bomb-sight (cross-hairs). The horizontal cross hair is stationary, while the vertical cross hair moves as a drum on the filar is turned. To make a measurement, you line up the vertical cross hair with an edge of a plated deposit. You then read the drum. Next slowly turn the drum until the cross hair just reaches the other side of the deposit. Take another drum reading and subtract the two readings. The difference multiplied by a factor (obtained during calibration) is equal to the thickness.

Both need to be calibrated using a stage micrometer (see next item).

5. A stage micrometer. This is a glass slide with a mirrored surface that has tiny scratches in it that are a specific distance apart. Most stage micrometers are NIST traceable, meaning that they have been calibrated against a NIST certified standard.

A nice accessory for the microscope is a camera port so that you can take pictures of what you see and keep records of readings. A digital camera is a must, if you plan on taking pictures.

The microscope needs to sit on a solid counter-top with no vibrations. You may need to invest in a cabinet with granite (or similar) top.

For the microscope and accessories, you will probably invest around $15,000+. You will need to hire someone to come in once a year and clean the microscope and calibrate it.

That's just the start. Next month we will continue. ***P&SF***