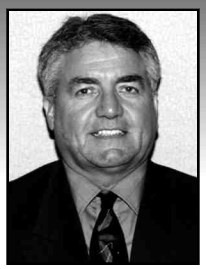

PulsePlating

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Pulse Coverage & Throw Testing

We don't usually produce electrodeposits of uniform thickness (as is done by electroless plating). Combining pulse and electroless has been done, but is there a way to get absolute uniformity on complex parts? Edges and projections receive higher current densities, recesses lower. Pulse plating with interposed reverse current pulses has some successes. Underpotential deposition, in most cases, plates epitaxially and is about as slow, by atomic layer. The manifold influences contributing to current distribution, such as activation energy, concentration polarization and hydrogen overpotential may be reviewed from three resources.[1–3]

Deposit Distribution

At the Pulse Symposium, I received a product bulletin on the Assaf Throwing Power (ATP) tester. I have listened for years to Yair Assaf about his test cell. Dr. Leisner has even successfully used it. It made sense. I would like to discuss information about the relatively new instrument that allows one to determine both covering power and throwing power in pulse plating.[4]

Covering power is the ability to deposit in low current density areas (like recesses) and around corners. Throwing power is the ability to uniformly build thickness with

increasing current. Adhesion and thickness uniformity are the most important plating characteristics. The Assaf Cell gives a simple and accurate way to determine the relative throwing power. Testing in this manner allows rapid evaluation of different plating conditions. The cell was originally designed to quickly find the best pulse for plating silver.

The Cell

The cell is a device that secures a 5.44 cm (2.14 in.) circular metal coupon suspended 4 mm (5/64 in.) above the flat plastic fixture. The plating area is 0.23 dm^2 (3.6 $in.^2$) per side. While plating, the front faces the anode, allowing the coupon to receive normal current, while the back side is blinded for lower current. Use of a circular shape affords small current density changes near the (front and rear) centers. These are the areas where the thickness measurements are made after the plating trial. Plating experiments can be held in the production tank or lab beaker. Do not use less than 1.5 L. Small volumes, such as those for Hull or Haring-Blum testing cells incur electrolyte composition changes during the plating, especially if insoluble anodes are desired.

Test Conditions

The current should be 36 percent of the normal current for 1 A/dm^2, or one-fortieth of the current for one ft^2 (1/40 of the desired A/ft^2). Plate a potential minimum of 0.0002 in. (5 microns). Stainless steel panels may be reused many times by nitric acid stripping. The anode should be greater than 10 cm (4 in.) from the cell.

The Plating Process

First, put the plate in the cell. Be sure that the plate is located in the two grooves, and then close both wing nuts. Hot soak the whole cell into a for a few minutes and rinse, then a few sec in hydrochloric acid and rinse. A 20 sec Wood's Strike at 1 A should precede 5-10 min in the plating solution in question. Remember the minimum thickness requirement. Always use the same conditions for data comparison. Rinse, dry, open the wing nuts and measure the centers.

Throwing Power

The ratio of the front center to backside center plating thickness is a measure of the relative throwing power. Changing plating conditions will let you see the effect on the throwing power: the shape of the pulse, pulse with reverse, pH, current, temperature, additives, solution components, etc. You will also see a wide range of current densities, like the Hull cell panel, owing to higher perimeter current density. Therefore, measuring the edge gives another data point for throwing power evaluation.

When pulse plating, it is recommended to look at current shape. This can be done by using an oscilloscope. The current differs from the voltage shape created by the pulse instrument.

In a commercial silver cyanide plating solution, with a current of 0.8 A/dm^2 (0.29 A for the cell), the front:rear for DC was between 2:3 and 3:4. Pulse plating achieved a 1:1 ratio. When the solution was badly contaminated by a wetting agent, there was only a small dull area on the back of the panel. It looked good, but checking the throwing power showed

an enormous ratio of 1:17. The same phenomenon occurs in acid copper. So throw cannot be seen. It can only be found by checking thicknesses.

After achieving best plating conditions for the cell in the lab, one must remember that these are the best test conditions—close to the ideal. They are not necessarily the best conditions for real parts in the plating tank (unless you're plating 2-in. circular plates).

In cyanide silver plating, a simple pulse was found to be good for simple production line parts. More complicated parts gave bad plating on areas with high current density. The burning issue was solved by implementing a small reverse pulse just after the on period and before the off period. The best throwing power conditions (ratio of 1:1) appeared to give the best electrical conductivity, equivalent to that of pure silver.

Throwing power is not everything. After finding good plating conditions for parts, one should continue checking plating conditions, which may influence other plate properties desired such as grain size, orientation, conductivity, reflectivity, mechanical strength, etc.

Covering Power

Reduce the testing current until the center of the back of the panel is not plated. Continue experimenting at that current while changing plating conditions. It is easy to see improvements in covering that area. How is covering power related to throwing power? (Hint: Answer is in ref.1–3, below:) P&SF

References

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(3) Dosenbach, O., Chap. 6, *Theory and Practice of Pulse Plating*, Puippe, J. Cl., Leaman, F., Eds., AESF 1986.
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