Rectifier Clinic

Craig Henry
J P Tech, Inc.
P.O. Box 863
East Troy, WI 53120
Phone: 262/642-7671
E-mail: craigh@jptechinc.com
Website: www.drrectifier.com

Spike Control for Rectifiers

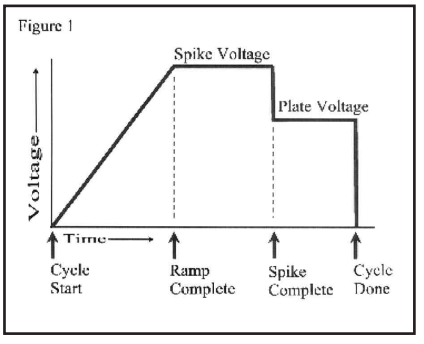

Fig. 1—Spike controller function.

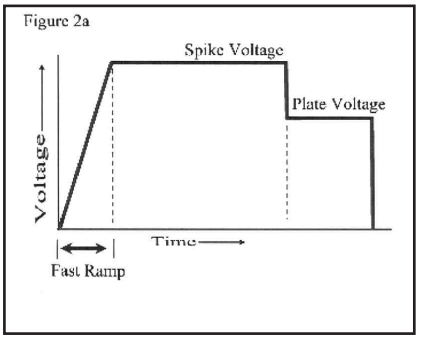

Fig. 2a—Fast ramp.

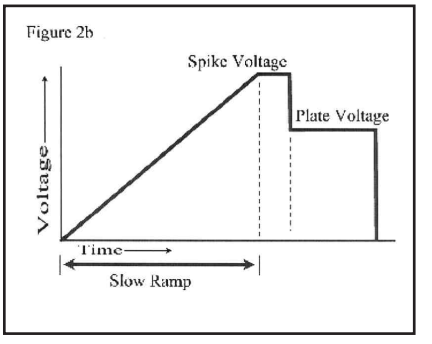

Fig. 2b—Slow ramp.

Overview

Some processes can be considerably enhanced by adding precise control features to the cycle. Because chromium plating is the most common application of this type of control, we will describe the use with that example. Spike control is designed to give the chrome plating operator greater control of the first stages of the process. Even though the typical controller has considerable range of adjustments, the chrome process dictates some specific areas that we can describe.

Basic Function

The basic function of a spike controller is shown in Figure 1. The process can be initiated either manually or by a limit switch tripped by the rack. In either case the cycle starts when the parts enter the tank.

The output voltage of the rectifier will increase at a preset rate to the spike voltage setting. Note that current will be present only if a part is in the plating tank. The preset rate of increase (slope/ramp rate) is set by a ramp time adjustment potentiometer on the controller. The amount of time it takes the rectifier's output voltage to go from zero volts to the spike voltage setting can be increased and decreased as desired by adjusting the ramp time pot.

The spike voltage potentiometer is used to set a temporary high voltage output from the rectifier. (High voltage may be from a half volt to several volts higher than the plate voltage.) This adjustment will be fine tuned to your process.

A timer is typically used to hold the spike voltage for as long as necessary to set the density and hardness of the initial plating. This timer can be adjusted to give several profiles that will be shown later.

The plate voltage potentiometer is used to set the voltage level for the duration of the cycle. This is usually set to the existing voltage level to duplicate the preferred deposition rate.

A final timer controls the overall cycle and either shuts the rectifier off or turns the output down until the start of the next cycle.

Although there is typically a provision for a current adjustment potentiometer, it will normally be set to full output. This allows the rectifier to achieve any current output up to the maximum possible. If the process calls for a limit on the current setting, this pot can be used to set the level desired.

Setting the Ramp

This example shows a general approach. The cycle can be tuned to fit your process and parts.

The ramp adjust potentiometer is used to adjust the length of time it requires the rectifier to go from zero volts to the spike value. Figure 2a shows a fast ramp with a rapid rate of voltage increase. Figure 2b shows a slower ramp with a lower rate of voltage increase.

Increasing and decreasing the ramp rate can greatly affect the plating results. When setting up initially. start with a midpoint. The ramp time can then be increased or decreased to optimize the results. Adjusting other settings may affect the location of the settings as well. Most chrome processes will function with a 10 to 20 second ramp time, but this will vary with bath chemistry and total deposition.

Setting the Spike Voltage

The spike voltage potentiometer sets the voltage for the initial part of the cycle, typically higher than the plate voltage. Figure 3 shows a "normal" spike voltage in relation to the plate voltage.

Continued on page 33

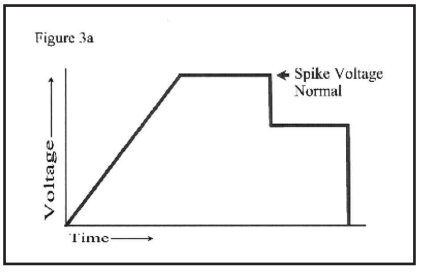

Fig. 3—Normal spike voltage.

7. W. Sun & D.G. Ivey, *Materials Science and Engineering*, **65B**, 111 (1999).
8. J.C. Doesburg, *The Structure and Composition of an Electroplated Gold-Tin Solder Alloy Co-deposited by Pulse Plating from Solutions Containing Ethylenediamine as a Stabilizer*, M.Sc. Thesis, University of Alberta, Edmonton, AB, Canada, 2000.
9. B. Djurfors & D. Ivey, *Proc. GaAs MANTECH Conference – May 2001 – Las Vegas, NV*, GaAs MANTECH, Inc., St. Louis, MO, 2001; p. 196.
10. A. He, B. Djurfors, S. Akhlaghi & D.G. Ivey, *Proc. AESF SUR/FIN 2002 – Chicago, IL*, AESF, Orlando, FL, 2002; p. 204.

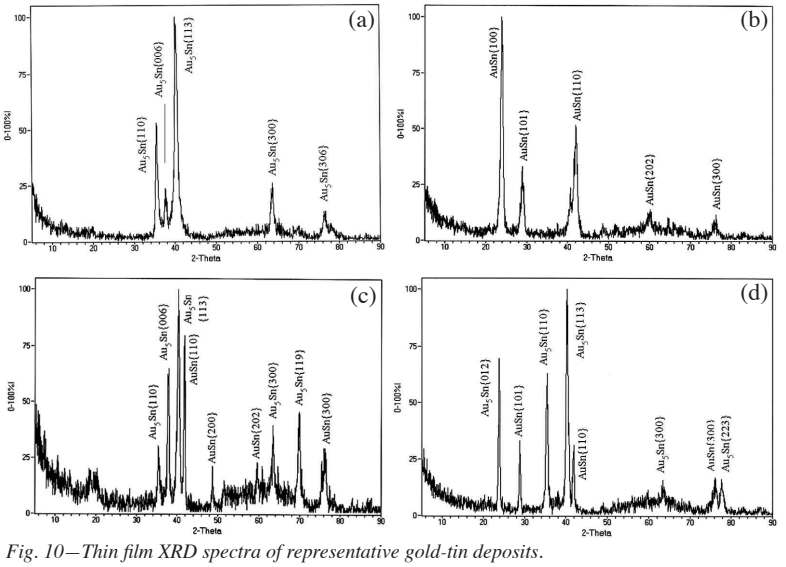

Fig. 10—Thin film XRD spectra of representative gold-tin deposits.
(a) 14.4 at% Sn plated at i = 0.4 mA/cm^2; 12 g/L KAuCl$_4$,
(b) 50 at% Sn plated at i = 3.5 mA/cm^2; 5 g/L KAuCl$_4$,
(c) 29 at% Sn plated at i = 0.8 mA/cm^2; 5 g/L KAuCl$_4$,
(d) 24 at% Sn plated at i = 4.0 mA/cm^2; 12 g/L KAuCl$_4$.

About the Authors

Yahui Zhang is currently a PhD student in the Department of Chemical and Materials Engineering at the University of Alberta. His research involves the electrodeposition of magnetic alloy coatings and gold-tin alloys for electronic packaging.

Dr. Douglas G. Ivey is a Professor in the Department of Chemical and Materials Engineering at the University of Alberta. He received his PhD in Engineering Materials from the University of Windsor (Canada) in 1985. His major areas of research interest include microstructural characterization of materials, metal/semiconductor interactions, alloy plating and corrosion of semiconductors.

Rectifier Clinic *Contined from page 20*

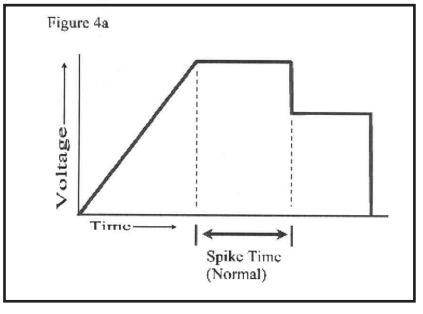

Fig. 4a—Normal spike time.

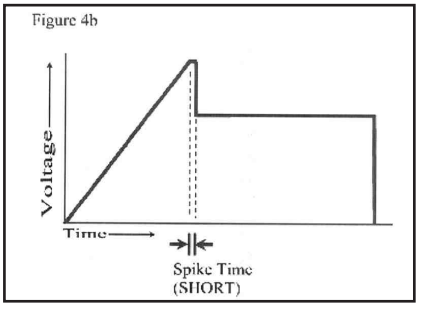

Fig. 4b—Short spike time.

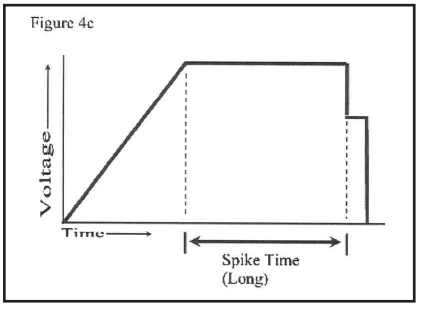

Fig. 4c—Long spike time.

Most chrome processes seem to work best when the spike voltage setting is in the range of 5.8 volts to 7.2 volts. If the setting is too high burning will occur. Fine tuning will involve adjusting the spike to the highest level possible without burning.

Setting the Spike Time

The spike timer is used to set the amount of time that the rectifier's output remains at the spike voltage setting.

Figure 4a shows a "normal" spike timer setting. This will usually be from one to five seconds after the rectifier has ramped to the spike voltage level. Figure 4b shows a short spike time while Figure 4c shows a longer spike time. It is usually easiest to start with a longer setting and dial the time back to the desired length.

Setting the Plate Voltage

The plate voltage potentiometer is used to adjust the plate voltage to the appropriate level for the bath chemistry and deposition rate. This is the portion of the cycle where most of the plating takes place. A typical starting point for chrome processes would be around 5.8 volts. This is a good starting point, if you do not have a desired voltage level.

Setting the Cycle Timer

This timer controls the overall cycle time, including ramp, spike and plate times. The total time will vary based on chemistry, load size, deposition rate, and part specifications.

Troubleshooting the Process

These guidelines are not absolutes but may be helpful in making final adjustments:

Burns in High Current Density Areas
- Spike Voltage is too high
- Spike time is too long
- Ramp time is too short

Whitewash in High Current Density Areas
- Ramp time is too long

Blueing in Low Current Density Areas
- Ramp time too short
- Spike voltage is too long

Low or Missing Plating In Low Current Density Areas
- Spike voltage too low
- Spike time is too short
- Ramp time is too long

For more detailed information, contact the author. ***P&SF***