Pulse Plating

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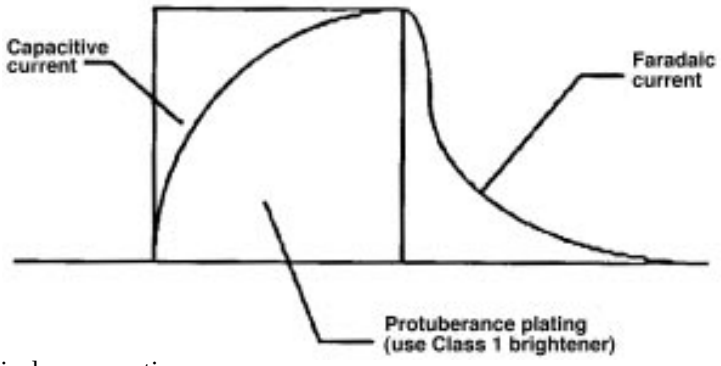
Heartbeat of America

What's the pulse of America? Currently in our case, the bottom line potentially does not mean much. One possibility concerns that bottom line in pulse waveforms. No one cares about the bottom line of pulse plating except upper management and those trying to do conformal plating (electroless, but with pulses).

Convincing upper management of the positive side of pulse is one thing, but the what about the negative side and platers? The complexity scares them off. Production shops rely on vendors so the sales elements to management are cost-cost-cost. We need not discuss cost savings from reduced chemical consumption, nor fewer processing problems and higher class technicians. We'll just stick to the current potential of pulse plating.



Consider the application of conformal pulse plating, as pulsed electroless is another subject. Referring to a previous "Pulse Plating" column (April 1999) and citation within, a pulse of current travels about one-third of the speed of light. This equates to about 1,000 ft per microsecond, which causes the rate of potential (voltage) to rise from the gate. This is the first part of the tracing of the waveform, as traced on an oscilloscope. You can control the voltage or the current, but not both. Such tracing is a potential one, usually displayed when using current control. Our concern is more with the actual work done in plating, so we are concerned with the current tracing, the product of voltage and time.

Current lags the changes in voltage. Surface resistance conditions cause this lag because plating occurs in an electrolyte and the electrolyte components have altered the metallic surface at zero potential, even if it is water at neutral pH. The more surface "modifiers" in the electrolytic solution, the longer it will take the

current to rise. The surface interface is known as the electric double layer. It must be first nullified before plating can occur. Like a circuit, it is a capacitor. Capacitance is a function of concentrations of active species in solution. So a rise in current follows an applied potential considering the charge species in solution. When plating is turned off, the potential reaches zero nearly as quickly as when turned on. The current discharges again proportional to the ionic milieu, enveloping the initial effects of capacitance. No current is lost, neutralizing the capacitive current. It is included in Faradaic current discharge.

Such Faradaic discharge is conformal. When current reaches the applied potential setting, it begins to plate where current concentrates, as on peaks, corners, edges, etc. To achieve conformal plating then, there is a requirement to not plate initially after the maximum current setting is achieved (see figure).

The problem comes in knowing when the amplitude of the current is achieved. This must be measured one way or another, or estimated. Another problem arises when protuberances are present. Primary current distribution may affect these areas, more so than the more uniform parts of the surface (in both macro- and micro-protuberances). With alloy plating, the correct timing of on and off must be considered for alloy heterogeneity.

Pulse Committee Update

The Pulse Plating Committee meeting at SUR/FIN® '99 focused on two things. First and foremost was organizing the Fifth International Pulse Plating Symposium (FIPPS), to be held in Chicago in conjunction with SUR/FIN® 2000 in June. The European Association of Surface Technology, AESF's International Branch and the International Union of Surface Finishers will contribute some speakers. By the time you read this, there should have been a call for papers. It is anticipated that there will also be speakers with topics on pulse alloy deposition, microelectromechanical structures, compositionally modulated alloys, electroforming, polishing, power supplies, anodizing, circuit board, plus some exotic stuff.

Also discussed at the meeting was the original 1986 book, *Theory and Practice of Pulse Plating*, Puippe & Leaman, Eds. It is being reprinted in paperback as needed, and is larger and appears better than the original soft cover. Copies quickly sold out at June's conference. Call the AESF Bookstore at 800/334-2052 to order. The Pulsed Electrodeposition Processes Committee is forging a companion volume II, *Applied Pulse Plating*. It will update and supplement citations in the literature, simplify theory, update previous contributors and include new and extended chapters on the realm of the subject. The committee hopes to have the two volumes, proceedings and video available for the FIPPS. P&SF