ACHIEVING A FINER GRAIN STRUCTURE USING THE INDIUM SULFAMATE PLATING BATH

The indium sulfamate plating bath is a common method of depositing pure indium onto conductive metallic surfaces. A relatively common misconception about the bath is that the deposit will have a smooth or mirror-like finish. However, a typical bath produces a frosted or matte-like finish. Granular formations can be seen in the deposit using a microscope. Granular growth is common for all soft metals that are electrodeposited, such as tin, lead, tin-lead alloy, and indium. For various reasons, it may be desirable to control the size of the grains that form and, typically, the desire is for smaller grains. (Bath chemistries generally include organic materials such as dextrose and triethanolamine, which inhibit grain growth.) This application note discusses methods in which smaller grains can be achieved. The following recommendations can be used in conjunction with one another.

Pulse/Periodic Reverse Plating — In this process, the current is cycled from on-to-off-to-reverse in a square wave cycle. Cycle times are generally in milliseconds where the on-time is greater than the reverse-time to effect a net deposition of metal. When the current is reversed, this causes the indium to "de-plate" off the work piece. This de-plating takes place at areas of high current density. The angular points of a crystal are a prime place for de-plating to occur. The de-plating tends to smooth out or reduce the size of the grains. This process involves a special pulse plate rectifier that is specifically designed for periodically reversing the current.

Current Density — Smaller grain size can be achieved by reducing the current density. This is limited by the fact that enough current is still needed to allow for plating to take place. A typical low-end current density would be 10 amps per ft^2.

Anode/Cathode Distance — Increasing the distance between the anode (indium) and cathode (work piece), to a certain extent, will reduce the grain size.

Agitation — Agitation, such as stirring, does not necessarily reduce the size of the grains. However, it can result in a smoother looking deposit. During the plating process, hydrogen bubbles form on the work piece. In a static bath, the bubble sticks to the work piece until it is large enough to cause buoyancy to pull itself off the surface of the work piece and float to the surface of the solution. No plating can occur at the site of the bubble while it is stuck to the surface of the work piece, and indium continues to plate around the bubble. This phenomenon produces a cratering effect. With agitation, the bubbles are stripped off sooner when they are smaller, therefore significantly reducing, if not eliminating, the cratering.

NOTE: In order to optimize the performance of the bath, it is important to make sure that certain parameters of the bath fall within the ranges specified by the bath manufacturer.

1. **pH** — Typical bath pH should be 1–3.5 (1.5–2.0 preferred). The pH can be adjusted by making additions of sulfamic acid. If the pH gets too high, the indium will precipitate out in the form of indium hydroxide, which causes the solution to assume a milky-white appearance.
2. **Indium Metal Content** — The bath typically is supplied at a concentration of 30 grams of indium metal per liter of solution. Because the anode efficiency is 100% and the cathode efficiency is 90%, the indium concentration tends to rise over time, leveling off at about 60–75 g/l. This is a normal situation and the rise in indium concentration does not affect the operation of the bath.
3. **Current Density** — The bath is typically operated at 10-20 amps per ft^2. The current density can be increased as high as 100 amps per ft^2 if the temperature can be maintained at 20–25°C. The use of cooling coils may be necessary to keep the bath at this temperature when operating at higher current densities.
4. **Anode Size** — The surface area of the anode should be equal to or greater than the surface area of the work piece(s).

APPLICATION NOTE

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