Electrodeposition: A Bright (But Perhaps Not Chrome-Plated) Future

by John Stickney

Here is the good news, folks! Electrodeposition is not just for breakfast anymore. No, no, no! We are coming out of the dark ages, into the light! Someone loves us and it is not our mothers! What am I talking about? To me, traditional electrodeposition harks back to images of a hunchback in a dark warehouse, stooped over boiling vats of cyanide and acid, bringing the world the largest selection of cheap jewelry, Harley Davidson parts, and car bumpers. We still need cheap jewelry and Harley parts, but chrome-plated car bumpers are a thing of the past in this plastics and environmentally-responsible age.

The way I see it, modern electrodeposition is one of the best methods for the formation of a dazzling array of high quality materials and structures: from electroforming space shuttle engines to the deposition of nanostructured films, wires, and crystals. The electronics industry has accepted electrodeposition as a full-fledged member of its construction tool box. For years it has been using electrodeposition for the formation of hard disk heads. It has now grown into the area of packaging (C4 solder bumps), and to being the method of choice for forming the tiny wires that connect transistors in ultra-large scale integration (ULSI) for the formation of microprocessors. We have two views of this technology in this issue, one from the tool maker's side, from John Dukovic (the 2004 winner of the Electrodeposition Division Research Award), who discusses how modern electroplating is performed in the semiconductor foundries. The other is from Tom Moffat on why electrodeposition works so well for filling up the nanoscale trenches used as interconnects in microprocessors. The process involves bottom-up filling, which is very hard to accomplish with classic deposition methods such as chemical vapor deposition (CVD).

Electrodeposition has many advantages as a method for the preparation of a very wide range of materials: from

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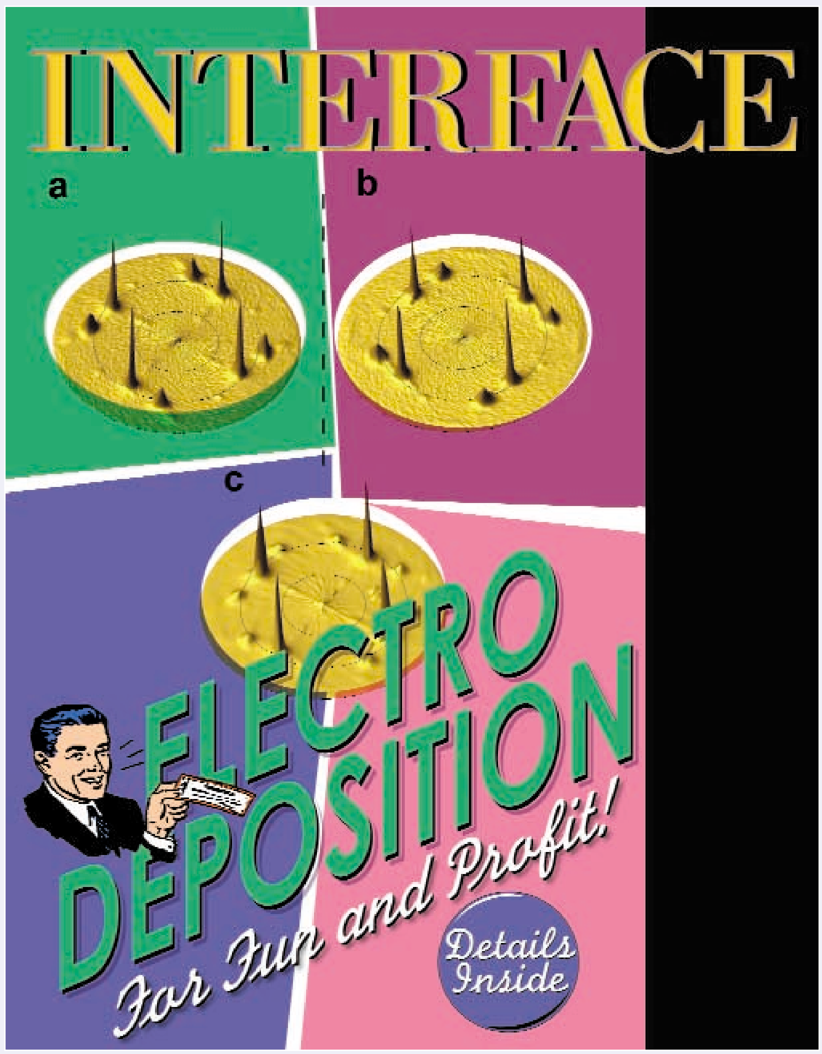
Our Featured Division

Electrodeposition Division



Electrodeposition...

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the LEGA process (a method for electrodepositing into thick patterned photoresists to form small parts with high aspect ratios) for micro-electromechanical systems (MEMS) to evolving nanoscale deposition methods. The Damascene process, developed for the deposition of copper by Panos Andricacos, *et al.*, and described in the above-mentioned articles, is the most important and commercially mature. As mentioned earlier, electrodeposition has proven to be a very versatile process as the ULSI community works on less than the 100 nm dimension scale.

A crucial advantage of electrodeposition is its inherent spatial selectivity, only depositing on conductive areas. In addition, electrodeposition can be performed on almost any surface geometry, from flat surfaces to the insides of tubes, even tubes with nanoscale internal dimensions. Electrodeposition is generally a room temperature technique, which makes it a low temperature technique, compared with nearly all other competing deposition methodologies. Reactions can be easily controlled using potential, current, or charge, as opposed to substrate temperature. There are also fascinating additive chemistries that can be taken advantage of to change the nature of deposits as they grow. The scope of electrodeposition is rapidly increasing, making it applicable for the formation of a much wider range of materials, including: metals and alloys (see The Chalkboard article by Dan Schwartz), but increasingly, semiconductors, and even oxides and insulators.

Two other articles are included in this issue that probe new directions for electrodeposition. The formation of nanoscale ordered structures is described by Phillip Bartlett, where he has used self assembly of hexagonal arrays of surfactant molecules to form templates for the electrodeposition of metals or semiconductors in ordered nanostructures. In addition, we have an article by Jay Switzer (the 2003 winner of the Electrodeposition Division Research Award), in which he describes how to form one of the most elusive materials, namely, chiral surfaces, by electrodeposition.

The Electrodeposition Division is growing younger and looking for a "few good" people with a view to the future. We are eager to be as inclusive as possible and to broaden our perspectives. Just as the field is rapidly changing, we want to keep on top of these trends, and it is only through advice from the Division membership that we have a chance. At the fall meetings of the Society, on Monday the Division has an informal lunch, organized by the vice-chair, where we invite all folks interested in Division symposia to get together and come up with ideas on what symposia we should be organizing, sponsoring, and who is going to do it. So I strongly encourage you to come to lunch with us. If you have wondered how to get involved, this is the best place to start. We need your ideas and your help to move this Division forward.

Besides support for symposia, the Division sponsors Student Travel Grants for each of the ECS's biannual meetings. Information on applying for these grants can be found in the Call for Papers of the meeting and on the ECS website. We also have a Division research award, and are looking for excellent candidates. Information on the Electrodeposition Division Research Award can be found on the ECS website. The nature of the award is to reward important advances in electrodeposition, as delineated by research recently described in one of the Society's publications. While there are lots of good people out there, this award is not necessarily for years of service to the Electrodeposition Division or to the Society, but rather, is meant to recognize someone who has recently moved the field forward. I strongly encourage you to participate by nominating deserving candidates.

The Division Luncheon is on the Wednesday of the fall Society meeting, where we go over what is happening with the Division, what symposia are planned, and other topics. It is also where both the Student Travel Award and the Research Award winners are introduced. It is a good forum to get to know some of the Division members, and we guarantee that the hunchbacks are few and far between these days. ■

About the Author

JOHN STICKNEY is a Southerner, born in South California. His academic background began in Berkeley, where he graduated in 1975 (from Berkeley High). He went on to a Humboldt fellowship (from Humboldt State University (CA)), where he received his BS in chemistry in 1981. For graduate school he went to UC Santa Barbara, where he performed UHV studies of the first monolayers of a metal as an electrodeposit forms, or underpotential deposition (UPD). He received his PhD in 1984, in chemistry. He has been at the University of Georgia (Department of Chemistry) since 1985, where he combined UPD and atomic layer epitaxy (ALE) to invent electrochemical atomic layer epitaxy (EC-ALE). Although John also is presently the department head, he still manages to do some surface modification in his spare time (see photo at left).