

A Brief History of Electroplating: The original nanotechnology.

Did you know that we just passed the 200th birthday of Electroplating, which coincided with the 40th anniversary of Moore's Law? Back around 1800, Luigi Brugnatelli, a friend of Alessandro Volta, started experimenting with Volta's 'voltaic piles' and various solutions. In 1805, Brugnatelli electroplated gold on silver becoming the first to ever electroplate something. Moreover, it may have been the first deposition, as CVD and PVD would not come for more than 100 Years. By the 1850's plating was a big business as Britain was in the midst of its industrial age.

By the 1900's, Science had moved in a different direction. Universities were chasing other problems, as the plating business matured and commoditized. As a result, it gained a *dirty, lo-tech* reputation, as it got grouped with the rest of industrial age technologies. After all, it was based on a pile, right? It always amazes me how one bad word can trip up a technology. The Army's use of the word bomb to describe the first high pressure oxidation systems doomed this technology to perennial questions about its safety. It never made it. Anyway, the 1950's represent the bridging of the Industrial and Information Ages. We get the birth of Hi-Tech: electronics that comes with the first commercial computers and the discovery of the transistor. Meanwhile, electroplating lay dormant until the 1970's, when **IBM's Lubomyr Ramankiv** aligned the research of plating with the business of plating. He took it from the Art Studio, through the Science Lab, and into Manufacturing. But their early applications were all in packaging. He was routinely kicked out of fabs for proposing the electroplating of copper for interconnect as a cheap alternative to sputtering.

Then serendipity happened. In the 1980's, **Hitachi** was convicted of Industrial Espionage against IBM. Part of the sentence was that Hitachi had to disclose everything it was doing. Through that, IBM learned of Hitachi's use of copper interconnect with PVD. IBM launched an internal research program and in the 1990's IBM, started researching Cu ECD. Initially they started working with **Semitool**, but the program was shifted to **Novellus** in 1995 over a disagreement. This is why both companies are strong today in this technology. Putting it in Novellus' hands meant that it would soon become a big deal, as Novellus is so good at marketing. Two years later, in 1997: Novellus video launched the Copper Revolution (you can see this video at www.chiphistory.org). Then in 2000: Copper went into high volume manufacturing and electroplating moved from Lab to Fab.

So why could electroplating be the first nanotechnology? Plating is about ion's chasing electrons, which all occurs at less than 100nm. More importantly, you are making entropy work for you. So what is nanotechnology? It's about making molecules working for you. It's less than 100nm and many include the concept of self-assembly. That's exactly what's happening with electroplating: self-assembly. Therefore: Plating = Nanotech, which leaves me with the question, did Brugnatelli invent Nanotechnology?

Electroplating really is a technology of the future. At this writing, there are all kinds of exciting new technologies people were working on. Like . . .

- Porous Silicon ... maybe a replacement for STI?
- Anodizing . . . Tantalum capacitors?
- Cladding magnetic materials on copper . . . MRAM?
- Ruthenium, Nickel silicides . . . Sub-45nm
- And More

The bottom line is that *Electroplating is a Solution in Search of a Problem*. We just need to go out and *FIND THE PROBLEMS!* Oh, and happy, belated, 200th Birthday.

— G. Dan Hutcheon
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