New stamping process creates metallic interconnects, nanostructures

Creating high-resolution metallic interconnects is an essential part of the fabrication of microchips and other nanoscale devices. Researchers at the University of Illinois at Urbana-Champaign have developed a simple and robust electrochemical process for the direct patterning of metallic interconnects and other nanostructures.

"Solid-state superionic stamping offers a new approach, both as a stand-alone process and as a complement to other nanofabrication techniques, for creating chemical sensors, photonic structures and electrical interconnects," said Nicholas X. Fang, a professor of mechanical science and engineering, and corresponding author of a paper published in the Feb. 14 issue of the journal *Nano Letters*.

The S4 process uses a patterned superionic material as a stamp, and etches a metallic film by an electrochemical reaction. In superionic materials, metal ions can move almost freely around the crystal lattice. These mobile materials can also be used in batteries and fuel cells.

Unlike conventional processing – in which patterns are first placed on photoresist, followed by metal deposition and subsequent etching – the S4 process creates high-resolution metallic nanopatterns in a single step, potentially reducing manufacturing costs and increasing yields.

The S4 process begins by carving the desired pattern into a stamp made of superionic material, such as silver sulfide, using focused ion beam milling. The stamp is then placed on the substrate and a voltage is applied. This produces an electrochemical reaction at the contact points of the interface. The reaction generates metal ions, which migrate across the interface into the stamp. As the reaction continues, the stamp progresses into the substrate, generating features complementary to the pattern on the stamp.

"The stamp acts like a sponge, soaking up metal ions," said Fang, who also is a researcher at the university's Beckman Institute for Advanced Science and Technology, and at the Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems.

"The most difficult step in the S4 process is making the stamp extremely flat and smooth," said graduate student Keng H. Hsu, the paper's lead author. "Currently, our resolution for patterning details is 50 nanometers. As better tools for engraving the stamps are developed, we will achieve finer resolution."

Ultimately, the resolution will be limited by the mechanical properties of the stamp, Hsu said.

Source: University of Illinois at Urbana-Champaign