

Researchers directly deposit gold nanoparticles in suspension

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The delivery, manipulation and assembly of functional materials such as metal nanoparticles into predefined architectures and patterns is of great interest in nanotechnology. Nanoscale patterns of nanoparticles have the potential to be used in miniature electronic circuits or in plasmon waveguides to guide the transport of electromagnetic energy below the diffraction limit. Nanoparticles functionalized with biological materials can also be placed between electrodes for use in biosensing applications.

Researchers from Northwestern University have now demonstrated the ability of a third-generation nanofountain probe (NFP) to directly deposit gold nanoparticles, 15 nanometers in diameter, onto silicon substrates. The research is published online by the scientific journal *Langmuir*.

“Such a direct-write method of deposition provides better control over resultant patterns and simplifies the process of fabricating functional structures, as compared to conventional photolithographic or microstamping techniques,” said Horacio D. Espinosa, professor of mechanical engineering in the Robert R. McCormick School of Engineering and Applied Science and co-author of the paper. Espinosa’s group pioneered the development of the nanofountain probe.

The NFP is a cantilevered probe chip that can be mounted on commercial atomic force microscopy (AFM) equipment. On-chip reservoirs hold liquid inks such as nanoparticle solutions, which are delivered through enclosed channels to ring-shaped apertured tips. High

throughput microfluidic transport of molecular inks to AFM tips is of great interest since fluid is a very effective medium for the direct delivery of molecules, which self-assemble on substrates with very specific nanoscale architectures.

“The ultimate goal of this project is to develop a robust microsystem platform for the mass production of nanoscale devices, sensors and structures using chemicals, biomolecules, nanoparticles, nanotubes and nanowires,” said Espinosa.

Previous versions of the nanofountain probes were shown to be capable of depositing solutions of fluorescent dyes, alkanethiols and DNA. Among several design changes, the latest nanofountain probes have deeper microchannels to allow the facile delivery of larger particles such as gold nanoparticles 15 nanometers in diameter.

Probe-based deposition techniques are amenable to high-resolution, nanoscale and flexible patterns in which the desired structure can be easily altered at any time. Dip-pen nanolithography (DPN), in which a commercial AFM probe is coated with molecules to be deposited, is capable of making high-resolution patterns of many chemicals and biological materials. However, standard DPN techniques have not been able to deposit suspensions of solid nanoparticles.

“The nanofountain probe is not only capable of delivering such solutions but can do so continuously because the inks are contained in reservoirs on the chip,” said Andrea Ho, a co-author and graduate student in Espinosa’s group.

Because NFPs are batch-fabricated using standard micromachining processes, they can easily be mass-produced. The current NFPs produce nanoscale patterns with a linear array of 12 writing tips, but their design allows for straightforward scaling up to 2D arrays of tips. This would

allow for the high-throughput, parallel deposition of nanoparticles with high resolution.

Source: Northwestern University

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