Why would an uneven coating of gold on a silica surface excite any interest, much less earn cover-story honors in a respected scientific journal?

This uneven coating - nanoparticles of gold in a layer that changes from very dense to very sparse across a surface of selected molecules - will allow improvements in a wide range of processes and devices. And it's the decreasing concentration of the coating and overlaying particles, the designed-in gradient, that has chemical engineers and physicists taking note.

"This material promises to be the first in a series with many applications in electronics, chemistry and the life sciences," said Rajendra Bhat, a doctoral student at North Carolina State University and principal author of the study published in the July 23 issue of Langmuir: The American Chemical Society Journal of Surfaces and Colloids.

What Bhat and his mentor - Dr. Jan Genzer, assistant professor of chemical engineering at NC State - have created is a surface coated with "sticky" molecules in a decreasing density. Like paint from a roller that starts out thick and gradually thins out, this sticky layer captures particles (in this case, gold) in the same pattern of decreasing density.

A kind of molecular template, this adhesive surface can be modified to attract different kinds of particles for different applications, all of them arranged in useful gradients. According to Genzer, the ability to vary and control the concentration of captured particles allows chemists and other scientists to devise sensors, filters, DNA-screening processes and, potentially, single-electron capacitors and transistors, among other possibilities.

Some components of fluids, for example, could pass through the gaps in the less-concentrated part of the gradient, but be blocked by the thicker concentration. Such filters could also be designed to detect or capture harmful viruses or toxins. The controlled distribution of particles also allows rapid testing of potential catalysts - always in demand by chemical, pharmaceutical and petroleum industries - because numerous substances and variations in their amounts can be tested simultaneously.

Genzer and Bhat initially attached gold nanoparticles to their sticky molecular template because gold is conductive, biocompatible and well understood. But experiments with other particles, bonded to other kinds of surfaces, are under way. The NC State chemical engineers admit they haven't thought of all the possibilities. "There are many more applications," said Bhat, "and we are open for collaboration."

Dr. Daniel Fischer, a physicist from the U.S. Department of Commerce's National Institute of Standards and Technology, collaborated with Genzer and Bhat on the project. Their novel invention was tested at the National Synchrotron Light Source at Brookhaven National Laboratory. Funding for the project was provided by the National Science Foundation, the Department of Commerce and the U.S. Department of Energy.

Genzer's research is also featured in the June 28 issue of Macromolecular Theory and Simulations.

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