

Friday, October 17, 2008

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Researchers write protein nanoarrays using a fountain pen, electric fields

October 14, 2008: A team of researchers at Northwestern U. has demonstrated the ability to rapidly write nanoscale protein arrays using a tool they call the nanofountain probe (NFP).

"The NFP works much like a fountain pen, only on a much smaller scale, and in this case, the ink is the protein solution," said Horacio Espinosa, head of the research team and professor of mechanical engineering in the McCormick School of Engineering and Applied Science at Northwestern.



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The results, which will be published online the week of Oct. 13 in the *Proceedings of the National Academy of Sciences* (PNAS), include demonstrations of sub-100nm protein dots and sub-200nm line arrays written using the NFP at rates as high as 80µm/second.

Each nanofountain probe chip has a set of ink reservoirs that hold the solution to be patterned. Like a fountain pen, the ink is transported to sharp writing probes through a series of microchannels and deposited on the substrate in liquid form.

"This is important for a number of reasons," said Owen Loh, a graduate student at Northwestern who co-authored the paper with fellow student Andrea Ho. "By maintaining the sensitive proteins in a liquid buffer, their biological function is less likely to be affected. This also means we can write for extended periods over large areas without replenishing the ink."

Earlier demonstrations of the NFP by the Northwestern team included directly writing organic and inorganic materials on a number of different substrates. These included suspensions of gold nanoparticles, thiols, and DNA patterned on metallic- and silicon-based substrates.

In the case of protein deposition, the team found that by applying an electrical field between the nanofountain probe and substrate, they could control the transport of protein to the substrate. Without the use of electric fields, protein deposition was relatively slow and

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sporadic. However, with proper electrical bias, protein dot and line arrays could be deposited at extremely high rates.

"The use of electric fields allows an additional degree of control," Espinosa said. "We were able to create dot and line arrays with a combination of speed and resolution not possible using other techniques."

Espinosa collaborated closely with Neelesh Patankar, associate professor of mechanical engineering at Northwestern, and Punit Kohli, assistant professor of chemistry and biochemistry at Southern Illinois University, Carbondale.

"We are very excited by these results," said Espinosa. "This technique is very broadly applicable, and we are pursuing it on a number of fronts." These include single-cell biological studies and direct-write fabrication of large-scale arrays of nanoelectrical and nanoelectromechanical devices.

"The fact that we can batch fabricate large arrays of these fountain probes means we can directly write large numbers of features in parallel," added Espinosa. "The demonstration of rapid protein deposition rates further supports our efforts in producing a large-scale nanomanufacturing tool."

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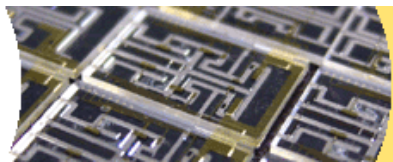
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