2009 Winner of the $500,000 Lemelson-MIT Prize
Dr. Chad Mirkin: Notable Inventions and Applications

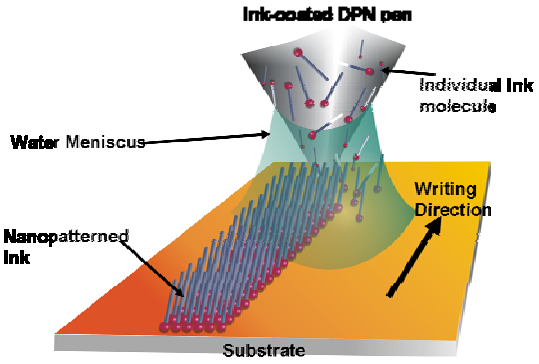
Verigene ID™ System and Accompanying Panel Assays

Dr. Mirkin created ultra-sensitive nanoparticle-based assays for proteins and nucleic acids to better identify and understand molecules that indicate early warning signs of disease. The ultra-sensitive detection systems are able to test patients for illnesses quickly without the need for expensive and complex lab work. The tests can be thousands of times more sensitive than conventional screening tools[1] and have the potential to definitively and quickly evaluate patients by detecting extremely low concentrations of proteins associated with specific diseases, allowing for early intervention and treatment.

Mirkin's inventions in this area the basis for the FDA-Approved Verigene ID™ System, a medical diagnostic tool commercialized by Nanosphere, Inc, a company co-founded by Mirkin. This diagnostic scanning device can be used to simultaneously test multiple patients and allows for the assessment of several disease-signaling nucleic acids or proteins. This new means of testing can be conducted on-site in a hospital or doctor's office in under an hour. The signaling of the disease targets relies on the use of gold nanoparticles decorated with DNA. The particles bind to the disease target and the signal is enhanced by using the particles as catalytic entities for depositing silver and growing them. This system is one of the first examples of the realized promise of nanotechnology in the medical arena.

Dip-Pen Nanolithography

Dip-Pen Nanolithography (DPN), a lithographic printing technique for surface science exploration, was invented by Mirkin and commercialized by NanoInk, another company founded by Mirkin. In this method, an Atomic Force Microscope tip is used to deliver a molecular "ink" to a solid surface via a solvent meniscus. The method can be rapidly scaled through the use of millions of "pens" in block arrays and then used as a printing technology with a nearly infinite number of molecules. This offers high-resolution surface patterning capabilities, giving scientists the ability to create and study matter on the sub-100nm-length scale. This work led to the commercial DPN tool called the Nscriptor™.



DPN can be used to manipulate proteins, DNA and other biological materials with a level of precision previously unknown, potentially leading to the development of novel therapeutics and diagnostics. The technology makes possible the study of biological systems at the single particle level, providing new insights into how cancer cells and viruses work. Mirkin is using DPN to probe fundamental surface science questions and create technologically relevant nanostructures such as the investigation of applications which allow parallel patterning. He is also developing procedures with DPN to pattern on semiconductor and insulator substrates and metals in order to extend the choice of inks.

Mirkin's latest invention, Polymer-pen lithography, utilizes millions of nanoscale pyramids as the ink delivery tools to cover large surface areas, and has even more potential commercial applications, ranging from computational tools, medical diagnostics like gene chips, and pharmaceutical discovery through combinatorial biomolecule arrays for screening drug candidates.

[1] According to C. Mirkin, the tests can be thousands of times more sensitive than conventional screening tools.

* Both the Verigene ID™ and Dip-Pen Nanolithography were born out of Northwestern University's Nanoscale Science and Engineering Centers, funded by the National Science Foundation. Mirkin's research group, with the help of Northwestern University graduate students, has successfully taken these inventions from lab to market. Photos courtesy of C. Mirkin.