NOVEL APPROACHES TO NANOSTRUCTURE ASSEMBLY AND NANOFABRICATION

Chad A. Mirkin

Department of Chemistry and International Institute for Nanotechnology, Northwestern University, 2145 Sheridan Road, Evanston, IL 60208-3113, USA
chadnano@northwestern.edu

Nanotechnology is a diverse field encompassing not only many disciplines but also many problems. The crux of many of these problems is our inability to design and produce complex nanostructures of desired form and function. Towards that end we have created three systems which allow for the creation of rationally designed nanostructures. In the first system we use a massively parallel two dimensional array of microscopic pens to generate discrete surface features of limitless complexity. These features, generated via Dip-Pen Nanolithography, can be produced with sub-100 nm resolution. Using a 55,000-pen array we are able to generate ~88 million objects in less than 20 minutes over an area of 1 cm x 1 cm. We have also extended our expertise in the area to the problem of generating discrete gaps with dimensions of less than 100 nm. Such gaps, if produced within a good tolerance, could find application in molecular electronics or for surface enhanced Raman scattering (SERS). In that vein we have developed a method of on-wire lithography (OWL) whereby gaps of controllable size from 100 to 3 nm can be consistently generated in gold nanowires. We show that these smaller gaps behave electrically like 3 nm tunneling gaps and could be adapted to molecular electronics. Similarly, we have used them to determine the relationship of gap dimensions to Raman enhancement factors in SERS. In our final example we have chosen to design heterostructures of nanoparticles in which two types of particles are joined in shapes ranging from satellite to dendrimeric to a "cats paw". In this system we make use of DNA hybridization for linking the particles and take advantage of the repulsive force of magnetic particles for the generation of the various shapes. These shapes are generated in high yield and are easily isolated.