

DNA-BASED NANOELECTRONIC MANUFACTURING TECHNOLOGIES

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ABSTRACT

Watson-Crick base pairing of DNA molecules is used to assemble metallic nanocomponents into regular two-dimensional arrays on a surface with unprecedented precision, programmability, and versatility. In this process, the base sequences of about two-dozen short strands of DNA bind together to form a thin DNA fabric, which is laid out on a surface. The DNA fabric contains rows of short DNA strands that serve as binding sites for attaching compositionally diverse nanocomponents (inorganic/organic) tagged with complementary DNA strands.

A versatile process for manufacturing 2D nanocomponent arrays with programmable component spacing and precise registry would enable a variety of applications including the development of nanoelectronic circuits based on regular arrays of devices, such as random access memories, programmable logic arrays, and cellular nonlinear networks. DNA provides a basis for self-assembly that can be programmed by base sequence design and offers a precision commensurate with its ~ 0.3 -nm nucleotide building block. Two-dimensional DNA crystals have already been used to organize other DNA molecules and protein molecules into regular 2D arrangements. Metallic nanoparticles, which represent a prototype electronic component, have been assembled into dimers and trimers by sequence-specific DNA hybridization, and short chains of metallic nanoparticles have been formed from streptavidin-labeled Au particles and biotin-containing DNA templates. In work by members of our research team, metallic nanocomponents have been arranged into 2D arrays by incorporating the nanocomponents into a DNA crystal during its growth. Recently, we have taken another important step toward DNA nanotechnology by assembling metallic nanocomponent arrays by hybridization of the nanocomponents to a preformed DNA scaffolding on a solid surface. Such templated assembly of nanocomponents on a surface has a wide range of applications. Here, we summarize our results for this approach, which could lead to a highly versatile nanoscale manufacturing process.