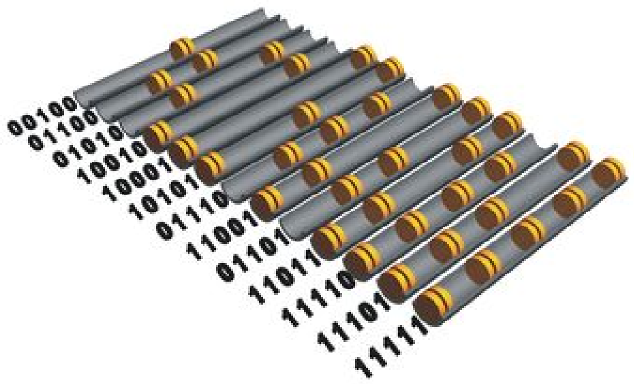
# Nanodisk Codes

27 December 2007, By Laura Mgrdichian




Physical binary codes formed by nanodisks carved out of nanorods. Image courtesy Chad Mirkin.

Researchers at Northwestern University have devised a way to use billionth-of-a-meter-sized disks to create codes that could be used to encrypt information, serve as biological labels, and even tag and track goods and personnel.

The nanodisks can form a physical pattern, similar in concept to a barcode, as well as a spectroscopic code, meaning it can exhibit a specific, unique response to electromagnetic radiation, or light, depending on the type of molecule (or molecules) attached to the disks—in other words, how the disks are "functionalized."

Nanostructures can be ideal for encoding. Their small size allows them to be hidden easily in a variety of materials and objects, and scientists' ability to easily tailor their physical and chemical properties makes it possible to design nanostructures for specific coding functions.

In a paper describing this work, published in a recent edition of *Nano Letters*, the researchers, led by Northeastern chemist Chad Mirkin, describe how the nanodisks can form physical binary codes. The group started with nanorods made of gold and nickel and, using a method they developed, carved disks out of each rod. The disks are created in twos, with up to five pairs created per rod.

Each of the five disk-pair locations along the rod can correspond to a "0" or a "1," depending on whether that location is occupied by a disk pair. For example, if only one disk pair is present, and it is situated at the third location, that code is read as 00100. If two disk pairs are present, at the fourth and fifth locations, the code is 00011.

"This is a rapid, low cost way of making many unique nanostructures that can identified and read based upon high sensitivity spectroscopic techniques," Mirkin said to *PhysOrg.com*. "It's a beautiful example of how the ability to shape and control the size and surface composition of a nanostructure can translate into significant technological advantages."

The group has made nanodisk arrays as long as 12 micrometers (millionths of a meter), which can support as many as 10 disk pairs, yielding 287 physical nanodisk codes.

The researchers increased the codes' usefulness by functionalizing them with a class of dye molecules called chromophores. This makes the codes spectroscopically active, allowing each to emit a unique light spectrum when illuminated by an exterior light source, typically a laser beam.

Due to the physical and spectroscopic codes they can exhibit, the nanodisks are particularly suited for biological tagging, a method of tracking and detecting individual biological materials, such as DNA. The researchers proved this by attaching pieces of single-stranded DNA to the surfaces of the nanodisks in a 11011 code. Each of these strands was complementary to half of a "target" DNA strand—the strand being tagged. The other half of the target strand was complementary to a "reporter" strand, rendered spectroscopically active with dye. The overall structure formed a three-strand "sandwich," with the target strand in the middle.

The group also created a similar sandwich structure using a different reporter strand and a 10101 code, and then mixed the two samples. They were able to successfully detect and distinguish between the unique spectrums emitted by both reporter molecules.

Citation: *Nano Lett.*, 7 (12), 3849-3853, 2007