Forging a new periodic table using nanostructures

Northwestern University's Chad A. Mirkin, a world-renowned leader in nanotechnology research and its application, has developed a completely new set of building blocks that is based on nanoparticles and DNA. Using these tools, scientists will be able to build—from the bottom up, just as nature does—new and useful structures.

Mirkin will discuss his research in a session titled "Nucleic Acid-Modified Nanostructures as Programmable Atom Equivalents: Forging a New Periodic Table" at the American Association for the Advancement of Science (AAAS) annual meeting in Boston. The presentation will be held from noon to 1 p.m. Sunday, Feb. 17, in Room 302 of the Hynes Convention Center.

"We have a new set of building blocks," Mirkin said. "Instead of taking what nature gives you, we can control every property of the new material we make. We've always had this vision of building matter and controlling architecture from the bottom up, and now we've shown it can be done."

Using nanoparticles and DNA, Mirkin has built more than 200 different crystal structures with 17 different particle arrangements. Some of the lattice types can be found in nature, but he also has built new structures that have no naturally occurring mineral counterpart.

Mirkin is the George B. Rathmann Professor of Chemistry in the Weinberg College of Arts and Sciences and professor of medicine, chemical and biological engineering, biomedical engineering and materials science and engineering. He is director of Northwestern's International Institute for Nanotechnology.

Mirkin can make new materials and arrangements of particles by controlling the size, shape, type and location of nanoparticles within a given particle lattice. He has developed a set of design rules that allow him to control almost every property of a material.

New materials developed using his method could help improve the efficiency of optics, electronics and energy storage technologies. "These same nanoparticle building blocks have already found wide-spread commercial utility in biology and medicine as diagnostic probes for markers of disease," Mirkin added.

With this present advance, Mirkin uses nanoparticles as "atoms" and DNA as "bonds." He starts with a nanoparticle, which could be gold, silver, platinum or a quantum dot, for example. The core material is selected depending on what physical properties the final structure should have.

He then attaches hundreds of strands of DNA (oligonucleotides) to the particle. The oligonucleotide's DNA sequence and length determine how bonds form between nanoparticles and guide the formation of specific crystal lattices.

"This constitutes a completely new class of building blocks in materials science that gives you a type of programmability that is extraordinarily versatile and powerful," Mirkin said. "It provides nanotechnologists for the first time the ability to tailor properties of materials in a highly programmable way from the bottom up."

Source: Northwestern University [1]

Links:
[1] http://www.northwestern.edu