University of Colorado
TECHNOLOGY TRANSFER OFFICE

Controlled Self-Assembly of Gold Nanoparticles Mediated by Novel Organic Molecular Cages

UNIVERSITY OF COLORADO

TECHNOLOGY TRANSFER OFFICE

Boulder + Colo. Springs
4740 Walnut Street
Suite 100
Campus Box 589
Boulder, CO 80309

(303) 492-5647

Denver + Anschutz Medical Campus
12635 E. Montview Blvd
Suite 350
Campus Stop F411
Aurora, CO 80045

303-724-0221

www.cu.edu/techtransfer

IP Status:

Patent pending; available for licensing.

Case Manager:

MaryBeth Vellequette

Email

Ref # CU3169B

Background

Artificial structured materials such as photonic crystals and metamaterials hold high promise of providing a path to by-design optical materials with engineered optical properties. In the past decade, this burgeoning field has seen explosive growth largely fueled by interest in the novel properties that metamaterials have. Metamaterials exhibit a negative refractive index, a phenomenon resulting from the engineered arrangement of artificial structural elements, which is a property that naturally occurring materials do not possess. Consequently, a sizeable amount of interest has been garnered towards metamaterials since substances that have a negative refractive index can potentially be used as components of super-lenses and high-performance metamaterial antennae. Also, engineers hope to use metamaterials in electromagnetic cloaking applications which might seem fantastic today but could soon become a reality.

Although researchers have lofty goals in mind for the future applications of metamaterials, there are still many problems hindering their commercialization. One of the major roadblocks for practical applications of metamaterials is the lack of efficient fabrication technology, which is also one of the grand challenges in nanotechnology generally. So far, the vast majority of optical metamaterials have been fabricated by top-down techniques such as electron-lithography or focused ion beam milling. While these techniques provide powerful means to sculpt nanostructures with high precision, they are slow, expensive, and generally limited to two-dimensional structures. An efficient and scalable technique capable of producing large-area three-dimensional structures is very much desired for the further development of metamaterial technologies. Fortunately, the self-assembly of nanoparticles offers an attractive solution to this problem.

Technology

Researchers from the University of Colorado led by Dr. Wounjhang Park and Dr. Wei Zhang have developed a method for the self-assembly of gold nanoparticles using 3D shape-persistent cage molecules. These 3D purely organic cages, also known as covalent organic polyhedrons (COP), are ideal for this application due to their unique shape-persistence, structure tenability, and chemical and thermal stability.

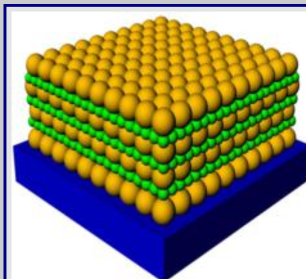

Figure 1. Shape-persistent 3-D cage molecules (COP) used for the layer-by-layer self-assembly of gold nanoparticles. The gold nanoparticles are in gold and the COP's are in green.

Significant progress in the development of dynamic covalent chemistry (DCC) has enabled the highly efficient synthesis of cage compounds in a modular fashion. The modular construction of cage molecules provides the design flexibility required to control the nanoparticle assembly process. In order for these organic cages to bind gold nanoparticles, they are first functionalized with pyridyl groups to provide the necessary anchoring sites. Self-assembly of the gold nanoparticles can be conducted in a layer-by-layer fashion. Each layer of gold can be laid on the substrate through the binding interaction between the gold surface and pyridyl groups on the COP. Multiple layers can be made through sequentially laying functionalized COP and gold layers on top of one another repeatedly (Figure 1). Through this process, self-assembled layer-by-layer structures with desired electric and magnetic properties can be produced.

Key Documents:

Controlled self-assembly of gold nanoparticles mediated by novel organic molecular cages. Optical Materials Express. 2013 Feb; 2(3):205-215. *PDF available upon request.*

"Novel Self-Assembling Nanocomposite Structures and Methods of Preparing the Same." Provisional patent application filed September 24, 2012; *available under CDA.*