

Nanotube Construction Set

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(PhysOrg.com) -- Organic nanotubes could make rapid strides as functional nanomaterials in a new approach to nanoelectronics and biomedicine, as they can be made of easily varied and modified building blocks.

Researchers led by Chulhee Kim at the Inha University in South Korea have recently developed nanotubes made of dendrons and cyclodextrins. As reported in the journal *Angewandte Chemie*, they have now successfully functionalized the surfaces of the tubes so that, among other things, they can be used to make biosensors for the detection of a specific protein.

Dendron is the Greek word for tree. Dendrons are tree-shaped branched molecules. Kim and Chiyong Park selected a molecular “tree” with four long hydrocarbon chains as “branches”. At the end of the “trunk” they attached a pyrene group, a system made of four aromatic carbon rings. In solution, these dendrons come together “branch to branch” to form vesicles, or tiny bubbles. If the researchers add cyclodextrins, which are ring-shaped closed chains of glucose rings, each of these settles around a pyrene group like a cuff. This makes it more favorable for the dendrons to group themselves into long nanoscopic tubes whose surfaces are coated with the cyclodextrin “cuffs”.

What makes this concept into a truly universal construction set is that the cyclodextrins can easily be equipped with a large variety of functional groups, which then dangle out into the solution from the surfaces of the tubes. The team was thus able to attach special groups that like to bind

gold nanoparticles. Nanotubes that are densely covered in metal particles could have interesting applications in nanoelectronics.

The pyrene groups on the nanotubes have another special advantage: they fluoresce. This property allows them to be used in the design of biosensors. To demonstrate this concept, the researchers constructed a specific test for the protein avidin. They equipped the surfaces of the nanotubes with biotin, a biomolecule that specifically binds the proteins avidin and streptavidin. If streptavidin bound to gold nanoparticles is added, these bind to the nanotubes by way of the biotin anchors. This brings the gold particles into the vicinity of the pyrene groups, which causes them to interact electronically, “switching off” the fluorescence. If the protein avidin and the gold-bound streptavidin are added, biotin anchors on the surface of the tube preferentially bind avidin. Pyrene groups in the vicinity of avidin fluoresce. The fluorescence quencher gold-streptavidin can only bind to the binding sites not occupied by avidin. The intensity of the fluorescence therefore depends on the avidin concentration.

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