Temperature-sensitive Nanobrushes

July 13 2005

Electrically conducting polymer with temperature-dependent optical properties and water solubility

The terms plastic and electrical current usually bring to mind such things as insulators or computer cases. It goes without saying that plastics are insulators, right? The discovery of conducting polymers actually resulted in a Nobel Prize in Chemistry for A.J. Heeger, A.G. MacDiarmid and H. Shirakawa in 2000—"plastic electronics" are on the move.

An American team has now developed a conducting polythiophene that demonstrates amazingly high water solubility and responds to the surrounding temperature as well.

Why the interest in electrically conducting polymers that are water-soluble? Water solubility allows for more environmentally friendly production processes. In addition, it is a requirement for many biological and diagnostic applications. Certain conducting polymers also respond to changes in their environment by a color change. This is just the thing for sensors that detect specific analyte molecules or indicate other parameters.

Polythiophenes, the most economically important class of conducting polymers, consist of long chains of five-membered rings containing four carbon atoms and one sulfur atom. Researchers led by Robin L. McCarley at Louisiana State University attached chains of a polyacrylamide derivative to a polythiophene backbone like bristles on the handle of a bottle brush. The "bristles" make the molecular "brushes" the most water-soluble neutral polythiophenes found to date.

But these bristles can do more: they respond sensitively to temperature changes. At temperatures under 30 °C, the brushes are in an irregular, stretched-out form and are loaded with water molecules. If the temperature is raised above 32 °C, these structures collapse into compact spheres, pushing the water molecules out. As a result, the entire brush responds to the conformational change of its bristles. From a stretched-out, only slightly balled-up form, it pulls itself into a compact spherical structure. This change decreases the water solubility of the brushes. More significantly, at the same time, the color changes; whereas a solution of the brushes at low temperature is orange-red in appearance, higher temperatures cause the color to change to yellow. This change in color indicates shifts in the electrical properties of the backbone.

Such water-soluble polymeric brushes, which react to external stimulation by changing their opto-electronic properties, could be used for biosensors in bioelectronics, as nanoswitches, light-emitting diodes, or fluorescence thermometers.

Source: Angewandte Chemie

Citation: Temperature-sensitive Nanobrushes (2005, July 13) retrieved 27 April 2024 from https://phys.org/news/2005-07-temperature-sensitive-nanobrushes.html