New probe for quantum dots

CHARACTERIZATION

Surface phenomena are a significant determining factor in the behavior of nanoparticles (NPs) because of their large surface-to-volume ratios but conventional spectroscopic techniques provide only limited information on NP surfaces. Researchers from Delft University of Technology in the Netherlands, Northwestern University, and Lawrence Livermore National Laboratory have devised a new way to probe the surface of quantum-dots using positrons [Cui et al., Nat. Mater. (2006) 5, 25].

“A slow positron often seeks out a defect site or surface and then annihilates to produce two gamma ray photons,” says Wen-Tong Tan. In addition, the large Stokes shift generated by the acceptor emission of the FRET NPs implies broad applications in labeling and imaging. It is also relatively easy to coat the silica NPs, so that these highly fluorescent, photo-stable NPs allow the simultaneous and sensitive detection of multiple targets. “By using these NPs, one can envision a dynamic, multicolor, colocalization methodology to follow proteins, nucleic acids, molecular machines, and assemblies within living systems,” says Tan.

Cordelia Sealy

Nanoparticles provide multicolor barcodes

BIONANOTECHNOLOGY

NP samples doped with different dye combinations under the same ultraviolet illumination (© 2005 American Chemical Society.)

Bioanalysis and molecular imaging are driving demand for fluorescent nanoparticles to use as tags. Quantum dots are attracting particular interest as they have broad excitation spectra and tunable emission wavelengths. They do, however, have some disadvantages. The preparation of quantum dots is still not satisfactorily reproducible, a full understanding of surface modification chemistry is lacking, and their ‘blinking’ emission limits usage in confocal microscopy and flow cytometry.

New researchers from the University of Florida have taken a new strategy to generate multicolor nanoparticle tags [Wang and Tan, Nano Lett. (2006) 6, 84]. These organic dyes were incorporated into silica nanoparticles using a modified Stöber synthesis method and, by varying their doping ratios, the researchers were able to tune the fluorescence resonance energy transfer (FRET)-mediated emission signatures. This produces NPs that exhibit different colors when excited by a single wavelength.

“Compared with other barcoding NPs, these NPs exhibit advantages such as easy preparation, intensely fluorescent, less toxic, non ‘blinking’, more hydrophilic and biocompatible, and providing versatile colors,” says Wen-Tong Tan. In addition, the large Stokes shift generated by the acceptor emission of the FRET NPs implies broad applications in labeling and imaging. It is also relatively easy to coat the silica NPs, so that additional functionality can be introduced. These highly fluorescent, photo-stable NPs allow the simultaneous and sensitive detection of multiple targets. “By using these NPs, one can envision a dynamic, multicolor, colocalization methodology to follow proteins, nucleic acids, molecular machines, and assemblies within living systems,” says Tan.

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Hollow victory for ZnS nanostructures

FABRICATION

Hollow nanostructures have many potential applications from photonic crystals to delivery systems to fillers and catalysts. Semiconducting nanoparticles, in particular ZnS, are of considerable interest because of their superior luminescence characteristics. However, the synthesis of hollow ZnS nanostructures has lagged behind other material systems and requires the use of silica and polyethylene spheres as sacrificial templates. Researchers from Shandong University and East China University of Science and Technology have now reported a simple, one-step chemical route to synthesize hollow and solid ZnS nanospheres [Gu et al., Langmuir (2005) DOI: 10.1021/la052539m].

The process consists of a simple refluxing of an aqueous solution of the reactants using thioacetamide as the S₂ source at a temperature of 103°C. The precursor solution is mixed at a molar ratio of Zn:acetamide 1:2. Primary ZnS nanocrystals are produced, which form spheres by oriented aggregation. The morphology and size of the nanospheres can be tuned by adjusting the experimental parameters. “Well-defined hollow and solid ZnS nanospheres have been synthesized without using template or laborious steps,” says Feng Gu of East China University of Science and Technology. The process can be easily scaled-up to produce gram quantities of the nanostructures. “This strategy may provide a new outlook in the exploration of modern chemical synthesis of well-defined nanostructures,” adds Gu.

The researchers are now optimizing the experimental conditions for more precise control of the morphology and size of the nanostructures, and applying it to other materials such as chalcogenide semiconductors.

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