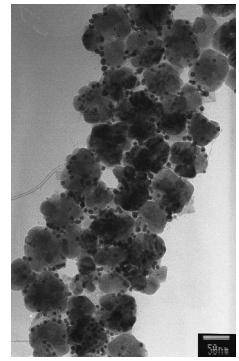
Golden Touch for Protein Separation

Nanomaterials have already proven promising in a wide range of biotechnological applications, especially as highly sensitive and selective sensors and separation elements. Among them, gold nanoparticles have often been used for biodetection of DNA and proteins. Gold's facile but robust interaction with thiol and disulfide groups enables functionalization of nanoparticles with molecules capable of specifically recognizing biological substances. Being magnetic makes them attractive candidates for applications such as diagnostics, therapeutics, separations, and magnetic resonance imaging.

However, gold nanoparticles have significant room for improvement. Nanoparticles combining gold and iron oxides inherit from the two components excellent surface chemistry, along with enhanced optical properties and superparamagnetic properties. Seeking to enhance the potential and broaden the applications of these bifunctional nanoparticles, Bao *et al.* (p 293) synthesized Au-Fe_3O_4 nanoparticles by simply linking two separately prepared nanomaterials by chemical bonds, rather than the more typical process of chemical deposition.

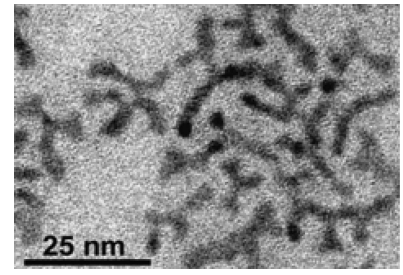


To prove their practicability and potential in bioapplications, the researchers used this material for protein separations. Combining their nanoparticles with protein (arginine kinase) in solution, Bao and colleagues used a magnet to remove the nanoparticles with protein attached. Bradford protein assay and SDS–PAGE results suggested that the protein was effectively removed from solution. Tests also showed that the protein maintained catalytic activity once separated from solution, suggesting that it was unharmed by this procedure. The authors suggest that other bifunctional or multifunctional nanomaterials similarly created could prove useful for further biological applications.

Labyrinthine Growth of Nanocrystals: Be A-Mazed

Semiconductor nanocrystals are luminescent nanoparticles that have discrete electronic structure caused by exciton confinement, and thus exhibit behavior similar to that of both discrete atoms and colloidal particles. The variation of confinement in semiconductor nanostructures provides a framework for testing new physical phenomena by manipulating the quantum aspect of these particles. In particular, varying the shape or size of the nanocrystals can modify the electron and hole wave functions. Previous efforts have led to the development of diverse nanostructures such as rods, cubes, and trees, as well as branched nanostructures that exploit the polytypism common in group II–VI semiconductors. Such materials can incorporate domains of cubic zinc-blende structure as well as hexagonal wurtzite structure within a single nanoparticle.

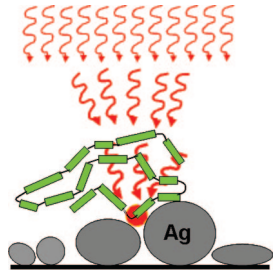
Previous studies have shown that sophisticated branched nanostructures can be synthesized by fine-tuning the relative stability of wurtzite and zinc-blende structures of CdSe. Working with this material, Lacerda *et al.* (p 337) formed labyrinthine CdSe nanoparticles that luminesce in the visible optical frequency range by growing these nanocrystals at relatively low temperatures in the presence of trioctylphosphine and hexadecylamine. This method grew open structures that had arms with spacings apparently regulated by the long-range dipolar interactions characteristic of CdSe nanoparticles. The emission spectra from these novel nanocrystals were narrow and could be tuned by



varying the arm configuration; however, these modifications did not change the luminescence lifetime. The researchers suggest that these properties could make this material a good candidate for applications requiring a robust material with a tunable and narrow emission spectrum.

Raman Spectroscopy: Homing in on "Hotspots"

Conjugated polymers are under investigation for applications such as light-emitting diodes, solid-state lasers, and photovoltaics due to the combination of processability, conductivity, and visible optical gaps they afford. Some recent single-molecule spectroscopic analyses have tried to explain photophysical effects displayed by these molecules using a "two species" model, which posits that these polymers have linear combinations of two types of chromophores: those in well-packed regions of the sample where interchain processes are manifest and those that are isolated and solution-like.



Unfortunately, photoluminescence of large molecules in condensed phases typically produces relatively diffuse spectra that provide limited structural information. In a new study, Wang and Rothberg (p 299) record Raman spectra of the conjugated polymer MEH-PPV at ambient temperatures, showing that it is possible to obtain structural and dynamical information from such studies.

The work builds on previous studies that have used Raman spectroscopy to look at single molecules adsorbed in favorable locations, or "hot spots", on nanotextured silver and gold clusters or surfaces. Using this technique, the researchers show that the chromophores divide roughly into those with broad spectra and those with narrower spectra, which supports respective loose and packed geometries. Wang and Rothberg notice considerable fluctuations in the spectra, which they ascribe mostly to motions of the chromophore in the hot spot. Their observations give an initial glimpse into the unusual phenomenology of single-chromophore Raman scattering, creating a foothold for future studies.

Published online November 30, 2007.
10.1021/nn700345c CCC: $37.00