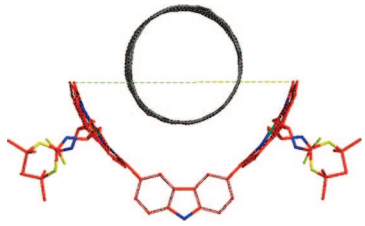
Tweezing Out Selected Single-Walled Nanotubes

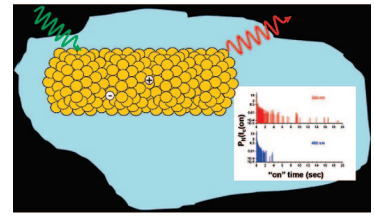
The selective synthesis and purification of single-walled carbon nanotubes (SWNTs) is a critical area of research since their electronic and optical properties can vary greatly depending on their structure and chirality. As-synthesized nanotubes contain both left- and right-handed helical forms (defined as *M* and *P*, respectively) in equal amounts. So far, there have been no reports of optically enhanced SWNTs (those enriched in either the *M* or *P* form), which are expected to have distinctive optical properties that could lead to technological applications in photonics, quantum optics, or photoelectronics.



Seeking a new way to sort SWNTs and to enhance these desirable qualities, Peng *et al.* (p 2045) developed chiral gable-type diporphyrins that act as "nanotweezers" that recognize selected molecules and can be used to separate them from the batch. Mixing different variants of these nanotweezer molecules with suspensions of SWNTs, the researchers found that they could extract mixtures of optically active SWNTs enriched in either the *M* or the *P* form. The researchers also found that the nanotweezers could be designed to discriminate between nanotubes having different (*n*,*m*) vectors. The method led to simultaneous enrichment of the abundance of (7,5) and (8,4) forms of SWNTs. Theoretical calculations suggest that the nanotweezers are capable of encapsulating SWNTs deeply enough to recognize diameter differences as small as 0.10 nm, thus leading to this (*n*,*m*) enrichment. This work is a significant step toward ultimately separating single species of SWNTs based on their diameters and helicities.

In a Blink: Investigating Fluorescence Intermittency in Nanorods

CdSe nanoparticles hold the promise of use in devices with optical properties that are continuously tunable across the visible spectrum, such as quantum-dot lasers, hybrid voltaics, and biological labels. Researchers have recently extended synthesis protocols to create one-dimensional (1D) CdSe nanorods, which may provide better charge mobility than zero-dimensional (0D) nanocrystals due to the elongated shape of the rods. However, nanoparticle "trap" states often result in charge losses that can harm the performance of nanoparticle-based devices by decreasing photoluminescence quantum yields. At the single-particle level, trap-state losses can cause nanocrystals and nanorods to display fluorescence intermittency, or "blinking," exhibiting power-law statistics over many decades in time. Understanding the mechanisms behind blinking is necessary before the ultimate implementation of nanocrystal- and nanorod-based devices.

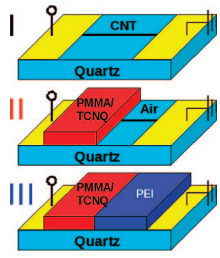


To determine how excitation wavelength and embedding media might influence blinking, Knappenberger *et al.* (p 2143) investigated these variables using CdSe nanorods. The researchers found that blinking behavior could be grouped into two distinct classes: excitation near the energy of the band gap, which results in more pronounced "on" probabilities in the distribution of "on" and "off" events, and energies exceeding 240 meV above the band gap, which were less likely to produce lasting "on" fluorescence. Measuring fluorescence for nanorods either deposited on a bare coverslip or embedded in a room-temperature ionic liquid, the scientists found that the liquid influenced blinking statistics only when the excitation energy exceeded the band gap plus 240 meV threshold. These results suggest that both excitation wavelength and embedding media could influence the performance of nanoparticle-based optical devices.

Nanotubes Light Up *p*−*n* Diodes

Carbon nanotubes have demonstrated promise in fundamental electron-transport studies and as functional components in next-generation electronic devices. However, theoretical studies have shown mixed results on how well a carbon nanotube would perform as the active element in a *p*−*n* diode, a critical component in most electronic and photovoltaic devices. One key issue that might affect the performance of a nanotube-based diode is breakdown of the diode under reverse bias (Zener breakdown), caused by a small depletion width within the nanotube. Researchers have devised several solutions for Zener breakdown, including chemical doping or separation of the *p* and *n* regions. However, these solutions have their own inherent difficulties that make use or fabrication cumbersome or that further degrade the device performance.

Looking to develop a new paradigm, Abdula and Shim (p 2154) fabricated semiconducting nanotube *p*−*n* diodes by simple patterning of polymers using conventional lithography. The team used deep-UV lithography of PMMA containing tetracyanoquinodimethane (TCNQ) on one side of the diode, followed by spin casting polyethylenimine (PEI) on the other side. They found that the half covered by PMMA/TCNQ exhibited *p*-type character, while the half covered by PEI was air-stable *n*-type. Tests showed that these diodes showed nearly ideal behavior with low series resistance and no sign of Zener breakdown at room temperature. Performance depended on relative doping levels, measured by micro-Raman spectroscopy and selective electrochemical gating of the *n*-region. The authors note that this initial study suggests that creating nanotube-based *p*−*n* diodes is possible without cumbersome fabrication steps or loss of performance.



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