crystals, through the incorporation of nonlinear optical nanoparticles. Other possibilities mentioned by the researchers include holograms with magnetic nanocrystals for magneto-optic applications and the incorporation of inorganic nanocrystals for multifunctional light-emitting devices.

STEVEN TROHALAKI

Sequential Synthesis of Colloidal Type-II Core/Shell CdTe/CdSe Semiconductor Nanocrystals Demonstrated

Semiconductor nanocrystals have been the subject of recent scientific and technological interest due to their promising potential applications, including photovoltaics and bio-imaging. In heterostructured nanocrystals, a higher-bandgap shell material can be grown onto a core material with a lower bandgap. Type II core–shell nanocrystals are materials engineered by their band offset (ΔE_v), and in these structures, the band offsets are such that the energies of the conduction and valence bands of the shell are either both higher or both lower than those of the core. These materials can spatially separate and confine photo-generated holes and electrons. A common-cation system, CdTe (core)/CdSe (shell) nanocrystals are type II materials, with the majority of photogenerated holes confined in the CdTe core and the electrons in the CdSe shell. Recently, K. Yu and co-workers from the National Research Council of Canada have developed an efficient approach to the synthesis of high-quality CdTe/CdSe nanocrystals. For the CdSe shell, by control of various factors, the technique avoids the formation of a thicker CdSe nanocrystal layer resulting in a thinner shell, leading to a higher photoluminescence efficiency. The researchers report their results in the March issue of *Small*.

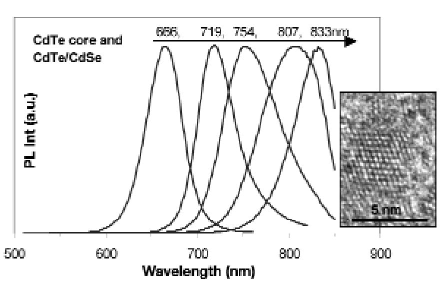

Figure 1. Photoemission spectra of CdTe(core)/ CdSe(shell) nanocrystals showing that the thicker the CdSe shell is, the more the emission redshifts. The inset is a transmission electron micrograph of one core–shell nanocrystal in an ensemble exhibiting 833 nm emission.

Colloidal type II CdTe/CdSe nanocrystals were synthesized by the sequential addition of a tri-*n*-octylphosphine telluride (TOPTe)/tri-*n*-octylphosphine (TOP) solution and several shell-precursor solutions to a cadmium oxide (CdO)/TOP solution. The shell-precursor solutions consist of CdO and tri-*n*-octylphosphine selenide (TOPSe) in TOP. This synthetic approach is simple and does not involve either the addition of any acids, amines, or traditional tri-*n*-octylphosphine oxide (TOPO), or precipitation of core CdTe nanocrystals.

During the synthesis of the type-II CdTe/CdSe nanocrystals, the researchers monitored the temporal evolution of the optical properties during the growth of the CdSe shell, as shown in the figure. The emission redshifts with increasing CdSe shell thickness.

This synthetic approach, similar to that of sequential anionic polymerization for well-defined block copolymers, is based on the knowledge gained during the search for synthetic routes for providing slow growth rates for high-quality CdSe and CdTe nanocrystals in large-scale production. It has been acknowledged that a slower particle growth rate results in less surface roughness, fewer surface defects, and higher photoluminescent efficiency. This synthetic approach is particularly well suited for realizing engineering materials with bandgaps in the near-infrared and infrared spectral ranges.

GOPAL RAO

Far-Field Technique for Visualization of Broadband Surface Plasmons Developed

Surface plasmons (SPs) are traveling waves that propagate along the interface of a metal and an insulator. Commercially available sensors for environmental and biological applications have been fabricated by tailoring the interaction between impinging light and SPs. Recently, SPs have been explored as a means of realizing metallic photonic circuits. Imaging the SP intensity distribution is essential to characterizing SP-based devices. Traditionally, this imaging has been accomplished by near-field and fluorescence techniques. As reported in the April 15 issue of *Optics Letters* (p. 884), A. Bouhelier and G.P. Wiederrecht of the Chemistry Division and Center for Nanoscale Materials at Argonne National Laboratory have developed a far-field method for exciting and observing the SP intensity distribution. The SP intensity distribution was imaged by detecting leakage radiation, which are two of the four electromagnetic modes that are solutions to the dispersion relations.

The researchers deposited silver films onto glass substrates using thermal evaporation. To avoid total internal reflection of the radiative modes, an index-matched, oil-immersed objective (numerical aperture of 1.4) was kept in contact with the glass substrate. The objective was part of an optical microscope, which was focused on the metal–glass interface. White light was used to excite a broadband surface plasmon continuum at the interface. This is possible because the objective introduced a distribution of wave vectors, through focusing, that fulfill the dispersion relation of the plasmon over the entire visible spectral region. The surface plasmon leakage radiation was recorded by a CCD camera that was placed in the image plane. A regeneratively amplified Ti:sapphire laser system was used to produce the incident white-light continuum radiation, which was polarized by a multi-wavelength wave plate and a Glan-Thompson polarizer.

Propagating SPs were visualized by recording the real-space distribution of leakage radiation emitted by SP waves at the dielectric–metal interfaces. The images reveal a spatial variation in the spectral components of the SPs, which the researchers have termed "rainbow jets," that extend a significant distance along the direction of propagation of the SPs away from the incident continuum radiation spot. According to Bouhelier and Wiederrecht, the observation of surface plasmon leakage radiation gives a direct measurement of the SP propagation length and the damping mechanisms for each wavelength. The study of surface plasmons and light–SP interactions opens possibilities for photonics because they allow the concentration and propagation of light below the usual resolution limit, which may enable the realization of wavelength-sensitive optical devices.

JEREMIAH T. ABIADE

Combination of Raman Scattering Techniques Achieve Single-Molecule Detection of Biomolecules

As molecular biology advances, the detection of low quantities of biomolecules is proving critical for some applications, said researchers T.-W. Koo, S. Chan, and A.A. Berlin of the Precision Biology group at Intel Corporation in their article published in the May 1 issue of *Optics Letters* (p. 1024).

Surface-enhanced Raman scattering (SERS), which has been demonstrated as a single-molecule detection method, benefits from signal increases on the order of 10^3–10^{15} primarily because of the electro-

https://doi.org/10.1557/mrs2005.131 Published online by Cambridge University Press