cusing, and clear images were taken with the lens focused to 10 cm and infinity.

The multilayering of the polymer actuator is an essential feature which enables it to operate at voltages compatible with hand-held electronics. Together with the fact that they can be easily microfabricated in wafer-sized arrays, these liquid lenses have considerable potential for use in commercial devices, according to the researchers.

Tobias Lockwood

$Bi_{12}TiO_{20}$ nanocrystals prepared by electrochemical synthesis exhibit excellent photocatalytic ability under visible light

Although titania (TiO_2) is a good photocatalyst, its use is limited to the ultraviolet range and thus cannot be used in the visible solar light range. $Bi_{12}TiO_{20}$ has emerged in recent years as a promising alternative that may be used in the visible range. However, current methods to synthesize $Bi_{12}TiO_{20}$ are not well-suited to prepare ultrafine, well-dispersed, crystalline nanoparticles that are desired for photocatalytic applications. Recent work from the China Building Materials Academy in Beijing has resulted in a new electrochemical route to prepare well-dispersed $Bi_{12}TiO_{20}$ nanocrystals.

Current solid-state synthesis and wet chemical methods used to prepare $Bi_{12}TiO_{20}$ require high temperature processing or special equipment that yield large-sized aggregated crystals which are at best sub-optimal for photocatalytic applications. Reporting in the May issue of the *Journal of the American Ceramic Society* (DOI: 10.1111/j.1551-2916.2011.04505.x; p. 1336), C. Gao, J. Ma, and co-workers prepared $Bi_{12}TiO_{20}$ nanoparticles by precipitation in an electrolytic solution using Bi and Ti plates as the anode and cathode, respectively. Adjusting the concentration of H_3PO_4 in the electrolyte caused a change in nanoparticle dispersion.

Electron microscopy revealed that a pure body-centered cubic (bcc) phase was formed in the absence of H_3PO_4 where the nanoparticles agglomerate into 2–3 μm spheres. However, increasing the concentration of H_3PO_4 increased the fraction of the face-centered cubic (fcc) phase with a concomitant weakening of the interparticle adhesion resulting in a well-dispersed $Bi_{12}TiO_{20}$ nanoparticle mixture of bcc and fcc phases.

UV-vis absorption spectra of the prepared samples revealed absorption onset wavelengths exceeding 500 nm, exhibiting good response in the visible light region. The $Bi_{12}TiO_{20}$ particles also efficiently degraded an RhB dye under visible light facilitated by the high specific surface area of the well-dispersed nanosized particles. Thus, electrochemical synthesis of $Bi_{12}TiO_{20}$ nanoparticles offers a promising new route to prepare photocatalysts that are responsive to solar light, according to the researchers.

Kaushik Chatterjee

Numerical simulations predict ultrasmall subwavelength plasmonic cavity

Plasmonic lasers (also called nanolasers), proposed about a decade ago, as well as other high-performance photonic devices, such as single-photon devices, require ultrasmall cavities. In contrast to diffraction-limited dielectric cavities, plasmonic cavities have resonant modes with subwavelength mode volumes. Although plasmonic lasing has been demonstrated, further mode-volume reduction is required for the high density integration of plasmonic devices. Toward this goal, S.-H. Kwon of Chung-Ang University in South Korea along with H.-G. Park and co-researchers at Korea University have proposed a novel plasmonic cavity and used numerical simulations to demonstrate mode volumes an order of magnitude smaller than previously achieved.

As reported in the June 1 issue of *Optics Letters* (DOI:10.1364/OL.36.002011; p. 2011), Kwon, Park, and co-researchers designed a plasmonic cavity consisting of a silver-covered, rectangular (100 nm × 200 nm) nanorod, composed of high- and low-index dielectric materials (refractive indices n of 3.4 and 1.5, respectively), atop a transparent sapphire substrate (see Figure 1). The researchers reasoned that surface plasmon polaritons (SPPs) can be efficiently excited at the nanorod–silver interface by optical pumping through the sapphire

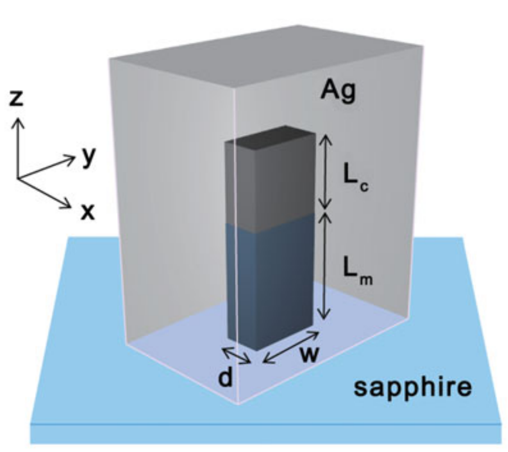

Figure 1. A schematic diagram of the surface plasmon polariton (SPP) cavity—a silver-covered dielectric nanorod consisting of a high-index material (dark grey) on top of a low index material (blue)—placed on a sapphire substrate.

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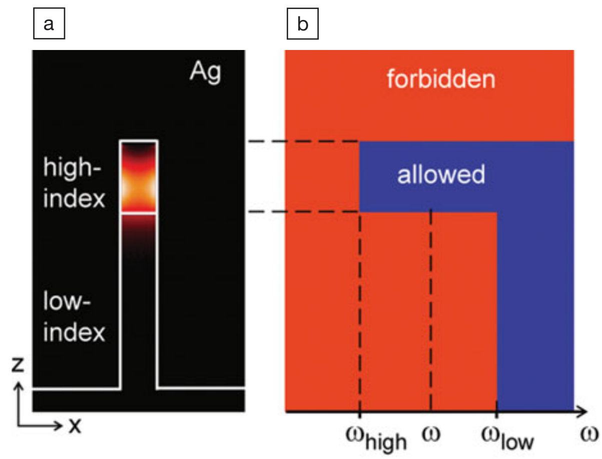

Figure 2. (a) The electric field intensity profile of the excited SPP mode within the SPP cavity. (b) The band diagram for the SPP mode corresponding to (a) shows allowed and forbidden regions drawn along the *z*-axis.

substrate. Strong SPP confinement is expected at the high-index dielectric–silver interface because of the large frequency gap between the SPP modes at the high-index dielectric–silver and low-index dielectric–silver interfaces.

Finite-difference time-domain (FDTD) simulations with 1-nm spatial resolution were used to quantify the mechanism. Two-dimensional dielectric core–metal shell waveguides (100 nm × 200 nm) displayed cutoff frequencies of 926 THz and 2072 THz for $n = 3.4$ and 1.5, respectively, but cutoff frequencies can also be controlled by varying the waveguide width and depth. The simulated electric field intensity profile confirms that SPPs are strongly confined at the dielectric—silver interface, with the electric field normal to the interface.

Three-dimensional FDTD simulations of the SPP cavity (with a dipole emitter 1 nm away from the silver sidewall to excite an SPP mode) were used to show that the SPPs are confined by two mechanisms—by metal reflection (at the upper end of the high-index dielectric, as expected) and by the frequency mode gap (at the lower end of the high-index dielectric). A band diagram of the fundamental SPP mode (see Figure 2) shows that when a given mode frequency is between the cutoff frequencies of the high- and low-index dielectric waveguides, the SPP mode is confined to the high-index dielectric interface. In addition, mode-gap confinement allows deep subwavelength SPP confinement (with mode volumes of $0.0038(\lambda/2n)^3 = 0.000012\ \lambda_0^3$) and enables efficient light excitation and collection through the sapphire substrate.

The researchers said, "Our SPP cavity with a large Purcell factor and ultrasmall mode volume is a strong candidate for high efficiency single-photon sources, low-threshold lasers, and ultrafast lasers using quantum wells or quantum dots. In addition, the SPP confinement mechanisms will also be useful in the solid-state cavity quantum electrodynamics experiments based on the GaAs material systems."

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