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.

Bi$_{12}$TiO$_{20}$ nanoparticles by precipitating Bi$_{12}$TiO$_{20}$ from an electrolytic solution using Bi and Ti plates as the anode and cathode, respectively. Adjusting the concentration of H$_3$PO$_4$ 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$_3$PO$_4$, whereas the nanoparticles agglomerates into 2–3 μm spheres. However, increasing the concentration of H$_3$PO$_4$ 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

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$_3$PO$_4$ 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$_3$PO$_4$, where the nanoparticles agglomerate into 2–3 μm spheres. However, increasing the concentration of H$_3$PO$_4$ 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

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 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.
complete characterization

Science continues to challenge the limits of material properties and capabilities. Whether improving conventional materials, such as tungsten alloys, or probing the potential of carbon fiber nanotechnology, our instruments and expertise help scientists characterize and confirm complex chemistries and unique structures. Our comprehensive offering includes innovative imaging and spectroscopy, industry-leading data management and proven method development. All designed to help provide deeper insights and more confident decisions as you drive bold progress in the materials of tomorrow.

speeds discovery in materials science

• www.thermoscientific.com/materialsscience
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(λ/2π)^3 = 0.000012 λ^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.”

Steven Trohalaki

---

**Call for Papers**

Manuscripts are solicited in the following topical areas, although submissions that succinctly describe groundbreaking work across the broad field of materials research are encouraged.

- Biomaterials and biomimetic materials
- Carbon-based materials
- Complex oxides and their interfaces
- Materials for energy storage, conversion and environmental remediation
- Materials for nanophotonics and plasmonic devices
- Materials theory and computation
- Mechanical behavior at the nanoscale
- Nanocrystal growth, structures and properties, including nanowires and nanotubes
- Nanoscale semiconductors for new electronic and photonic applications
- New materials synthesis, templating and assembly methods
- New topics in metals, alloys and transformations
- Novel and in-situ characterization methods
- Novel catalysts and sensor materials
- Organic and hybrid functional materials
- Quantum matter
- Surface, interface and length-scale effects on materials properties

For manuscript submission instructions, please visit www.mrs.org/mrc-instructions. For more information on MRS Communications, please visit www.mrs.org/mrc or e-mail mrc@mrs.org.