CdSe Nanocrystals Enable New Methods for Color-Selective Semiconductor Laser Fabrication

Hans-Jürgen Eisler and colleagues from the Massachusetts Institute of Technology and Los Alamos National Laboratory have developed an optically pumped nanocrystal distributed-feedback (DFB) laser that uses wet chemistry methods to produce nanocrystal titania waveguides. The researchers report in the June 17 issue of *Applied Physics Letters* that the emission wavelength of the nanocrystals is a function of their size. The wavelength of the nanocrystal-based DFB laser is chosen by varying nanocrystal size and by adjusting the refractive index of the waveguides through the volume fraction of nanocrystals.

The research team determined the amplified spontaneous-emission profiles of the nanocrystal titania waveguides and matched them to appropriately spaced direct-feedback gratings to provide feedback and demonstrate lasing. A solution of CdSe and CdSe(ZnS) core-shell nanocrystals, synthesized to be resilient to alcoholic solvents and arranged into a titania matrix at high volume fractions, was spin-coated onto silica substrates and annealed at 200°C to produce a clear, nanocrystal titania composite film. These samples were used to determine emission profiles. In the production of the lasers, the refractive index of the film was adjusted through its nanocrystal volume fraction to match the Bragg condition of lithographic gratings with periodicities of 310–350 nm. The gratings were fabricated by reactive ion etching on the 1-μm-thick thermal oxide grown on silicon substrates, then the appropriate nanocrystal titania film was deposited. To test the resulting structures, the samples were initially cooled to 80 K, and a 400-nm pulsed excitation light was focused onto the structures. The resulting photoluminescence emission was coupled into a spectrometer and examined with a CCD camera. Emission from the front of the structure collapses into a visible laser beam, the researchers reported.

Alternatively, several direct-feedback lasers operating in the 560–625-nm range were created using a 350-nm grating periodicity, but the size and volume fraction of the constituent nanocrystals was varied, demonstrating the ability to tune the wavelength of these lasers, for a given grating periodicity, using only the nanocrystal size and volume fraction. These nanocrystal lasers exhibit thermal stability at room temperature and at 80 K.

The thermal stability and precise tunability of these nanocrystal lasers suggests that other materials may be suitable for the creation of nanocrystal lasers operating in the ultraviolet or infrared regimes.

CHRISTINE RUSSELL

Cobalt-Based Metal Oxide Negative Electrodes May Enable Practical Low-Voltage Li-Ion Cells

The rapid development of innovative technologies in portable electronics for new and efficient power sources has led to great interest in lithium-ion batteries, due to their excellent electrochemical performance and design flexibility. With the continuing trend toward lower operating voltage in electronic devices, a lower-voltage Li-ion cell with large capacity and reversibility is desirable. To improve device performance, researchers from Telcordia Technologies in Red Bank, N.J., and LRCS at the Université de Picardie Jules Verne in Amiens, France, were able to optimize the Li-ion cells using three-dimensional (3D) metal oxides, specifically CoO and Co_3O_4, as an alternative negative-electrode composite. Both cobalt-based metal oxides show comparable performance with the present-day Li-ion batteries at a lower operating voltage, with the combination of $Li_{1+x}Mn_2O_4$ positive electrode.

As reported in the June issue of *Electrochemical and Solid-State Letters*, F. Badway and co-workers first used the polyol process to prepare monodisperse

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