and even quantum computing.

For example, by layering a superconducting material onto the surface of a topological insulator, it may be possible to create a theoretical but yet unseen particle that is its own antiparticle, one that could persist in the material undisturbed for long periods. Discovery of these so-called Majorana fermions would be an achievement in itself, and could also provide a way of overcoming the main obstacle to realizing a working quantum computer, a method of indefinitely storing data as "qubits."

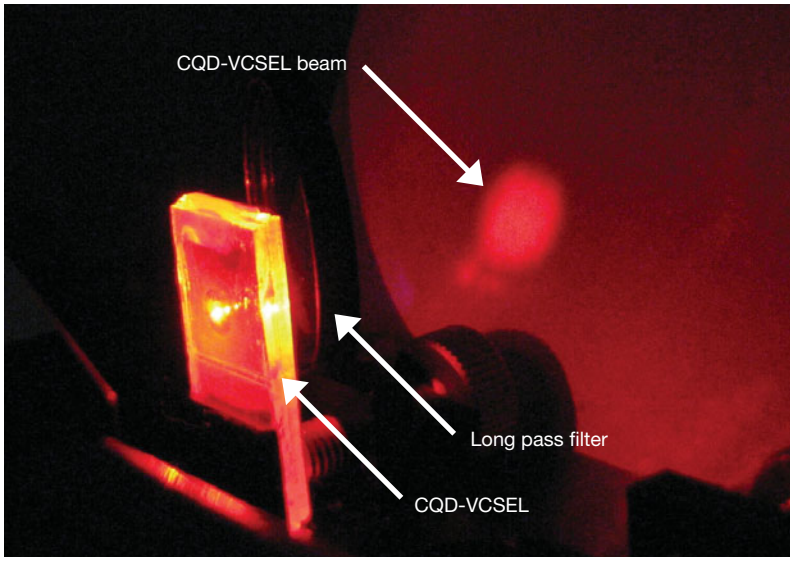
Nano Focus

Colloidal quantum dot films show RGB lasing

Colloidal semiconductor quantum dots exhibit efficient luminescence and bandgap controllability due to quantum confinement effects. However, to obtain laser emission from these materials, it is necessary to achieve a high colloidal-quantum-dot (CQD) packing density, and to reduce losses arising from nonradiative, multi-excitonic (Auger) recombination. In a joint collaboration, C. Dang of Brown University, C. Breen of QD Vision, Inc., Massachusetts, and their colleagues have demonstrated how these requirements can be met to achieve red-green-blue (RGB) lasing.

As published in the May issue of *Nature Nanotechnology* (DOI: 10.1038/nnano.2012.61; p. 335), the researchers report lasing emission from CdSe/ZnCdS core/shell CQD with aromatic ligands. These form densely packed films that exhibit optical gain across the visible spectrum with an average of less than one exciton per CQD. This single-exciton gain allows the films to reach the threshold of amplified spontaneous emission at very low optical pump energy densities of 90 μJ cm^{-2}. This is more than one order of magnitude better than previously reported values. The gain of these nanocomposite films was used to produce the first colloidal quantum dot, vertical-cavity surface-emitting laser (CQD-VCSEL).

In this work, the researchers prepared type I CdSe/$Zn_{0.5}Cd_{0.5}S$ core/shell CQDs by high-temperature organometallic synthesis with nominal CdSe core diameters of 4.2 nm, 3.2 nm, and 2.5 nm. The thin (1 nm) ternary shell reduces strain and creates a moderate core/shell bandgap difference. Transmission electron microscopy images showed well-defined crystallinity and "pyramid-like" morphologies. Together, these properties modify the electronic states from those of ideal spherical CQDs, where the anisotropic shape of the CQDs is a key feature that enables lasing with one single exciton.



Photographic image of a red colloidal quantum dot, vertical-cavity surface-emitting laser (CQD-VCSEL) showing a spatially well-defined output beam, which is collinear with the pump beam. Reproduced with permission from *Nat. Nanotechnol.* **7** (2012) DOI: 10.1038/nnano.2012.61; p. 335. © 2012 Macmillan Publishers Ltd.

In ideal spherical CQDs, the Auger process is typically two orders of magnitude faster than photoluminescence decay, which severely hinders the dynamic buildup of population inversion. In this work, the dynamics of optical gain in CQD films were studied in pulsed stripe, photoexcitation experiments. Emission from the film edge with increasing pump power exhibits a clear transition from photoluminescence to stimulated emission (here observed as amplified spontaneous emission, ASE) through an abrupt increase in output intensity and spectral narrowing.

In contrast, in the densely packed CQD films, the ASE process is so fast that it can readily overcome this Auger loss. Indeed, very low thresholds of ASE across the RGB spectrum were obtained and the first CQD-VCSELs by single-exciton gain in type I CQD films were reported. Single-exciton gain was confirmed in this work by four independent

Correction

The affiliations for the authors of the article, "Survey reveals interdisciplinarity of MSE faculty," published in *MRS Bulletin* **37** (June 2012) p. 541, are Parag Banerjee, Department of Mechanical Engineering and Materials Science, Washington University, St. Louis, MO (parag.banerjee@wustl.edu) and Robert M. Briber, Department of Materials Science and Engineering, University of Maryland, College Park, MD (rbriber@umd.edu).

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