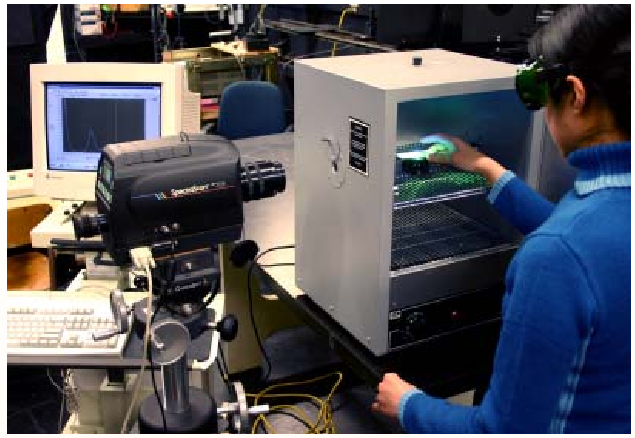
Evaluating Nanocrystal Quantum Dots

Presently, white LEDs are created by combining inorganic phosphors with nitride-based blue or UV (ultraviolet) LEDs. However, it is difficult to achieve a tailored-spectrum white light with available phosphors. Semiconductor nanocrystals, known as quantum dots, may provide an alternative. Quantum dots behave like phosphors, but they can be tuned to radiate any color simply by changing the physical size of the dot. Because the solid-state lighting community is aiming to develop white LEDs with certain spectral characteristics, researchers are now looking to quantum dots as a new resource.



An LRC graduate student positions a microscrope slide coated with quantum dots over a UV LED. This quantum-dot LED is placed inside a special oven to study its photometric and thermal properties.

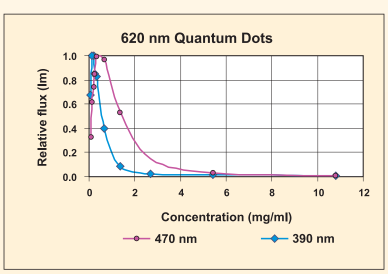
Initial study

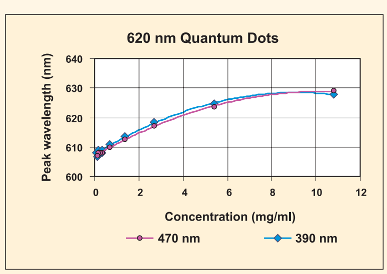
The LRC conducted an initial study to characterize cadmium selenide-based quantum dots and assess their potential use in the development of good quality, white light LED systems. Quantum dots that emit monochromatic light at 520 nm (green) and 620 nm (red) wavelengths were tested to understand their photoluminescence properties. An initial batch showed relatively low quantum yields and high thermal sensitivity. However, a subsequent batch showed improved performance. Therefore, in the future these types of quantum dots may become useful for creating white LEDs.

Ongoing study

The LRC is continuing to study quantum dots as an alternative to phosphors for creating white LEDs. With Evident Technologies, the LRC will:

- Analyze the photometric and optical characteristics of different sizes of quantum dots
- Identify methods to incorporate quantum dots with short-wavelength LEDs to produce good quality white light
- Evaluate the resulting white LED systems' performance





In one experiment, researchers measured the photoluminescence properties of quantum dots mixed into a chemical solution at different concentrations. The left graph shows relative light output as a function of quantum dot concentration when excited by 390 nm and 470 nm wavelength radiations. The right graph shows that the peak wavelength shifts to a longer wavelength when concentration increases. By selecting the optimum concentration, researchers can maximize the radiant power and efficiency of a quantum-dot LED.

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