

Energy Focus
Quantum dot layer fine-tuned for higher efficiency QLEDs

Light-emitting devices (LEDs) using semiconductor film architectures and technologies are generally preferred over quantum dot emitters (QLEDs) due to their higher luminous power efficiencies. However, QLEDs offer a number of significant advantages, including the ability to tune the emission wavelength according to particle size, and narrow bandwidth emission. Several device designs have attempted to optimize important charge injection and transport properties of QLEDs through chemical and engineering approaches. Recently, B.S. Mashford of QD Vision, Inc., V. Bulovic and M. Bawendi of the Massachusetts Institute of Technology, and their colleagues have developed an inverted hybrid organic–inorganic device using colloidal CdSe–CdS core–shell

quantum dot (QD) emitters. They demonstrated electroluminescence that can compete with those of current organic LEDs, and they provide evidence for interesting correlations between efficiencies and the quantum dot layer thickness.

As described in the May issue of *Nature Photonics* (DOI: 10.1038/NPHOTON.2013.70; p. 407), the researchers built devices with colloidal CdSe–CdS core–shell QD layers of varying thickness. Initial voltage biasing showed that all the devices turned on close to 1.5 V, giving power efficiencies as high as 25 lm W⁻¹ due to the low drive voltage. However, when comparing current efficiency, they noted that there is somewhat of a tradeoff between the electroluminescence yield and the operating stability. The thicker QD layers initially exhibit much higher electroluminescence, but this quickly decays due to inefficient charge transfer. The thinner QD layer devices show

the opposite behavior with a fast rise in intensity, followed by a much longer decay process. The researchers explain this contrast through an ultrafast charge transfer, which is facilitated by the well-aligned electronic levels between layers, as evidenced by surface potential measurements showing small variations (~0.1 V). This energy-level alignment and device stability is facilitated through the use of a ZnO nanocrystalline film for the electron-injection layer, which has previously shown promise in organic–inorganic hybrid devices.

This work demonstrates the feasibility of fabricating solution-processed QLEDs with luminous efficiencies that could compete with current state-of-the-art LEDs. These detailed studies also further develop the understanding of several important photophysics processes, which can find applications in other areas of technology.

Christopher Patridge

News
Materials Researchers
2013 L'ORÉAL-UNESCO Awards for Women in Science honors materials researchers

Each year, five outstanding women scientists—one per continent—are honored for the contributions of their research, the strength of their commitments, and their impact on society. This year, the research of the 2013 Laureates demonstrates exceptionally original approaches to fundamental research in the physical sciences with a notable relation to materials research. The award recipients include

Marcia Barbosa of the Federal University of Rio Grande Sul, Porto Alegre (Brazil) for “discovering one of the peculiarities of water which may lead to better understanding of how earthquakes occur and how proteins fold which is important for the treatment of diseases.” Water can behave in unusual and unex-



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pected ways, and pinpointing exactly how water acts, and why, when it does the unexpected is key to advancing knowledge in nearly every field of science.

Pratibha Gai of the University of York (United Kingdom) received the award for “ingeniously modifying her electron microscope so that she was able to observe chemical reactions occurring at surface atoms of catalysts which will help scientists in their development of new medicines or new energy sources.” Her modification and development of the atomic resolution-environmental transmission electron microscope enable scientists to actually see chemical processes at the atomic level that were once completely mysterious.

Deborah Jin of the National Institute of Standards and Technology, and University of Colorado, Boulder (USA) is recognized for “having been the first to cool down molecules so much that she can observe chemical reactions in slow motion which may help further understanding of



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molecular processes which are important for medicine or new energy sources.” The study of ultracold molecules could lead to new precision-measurement tools, new methods for quantum computing, and increase scientific understanding of materials that are essential to technology.

Reiko Kuroda of Tokyo University of Science (Japan) was recognized for “discovering the functional importance of the difference between left handed and right handed molecules which has wide applications including research on

neurodegenerative diseases such as Alzheimer’s.” Her basic research at the molecular level, whether biological or non-biological, has important implications for manufacturing drugs and agricultural chemicals, as well as for the study of gene-determining animal body asymmetry, such as snail coiling. □



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