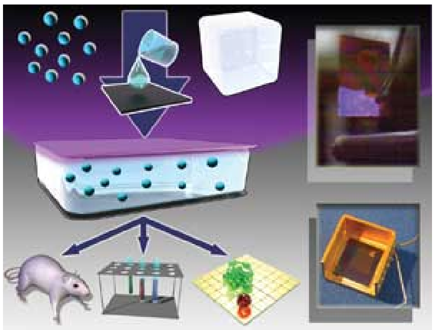
Inorganic glass LEDs emit in the UV

Ashley N. Paddock, ashley.paddock@photonics.com

LOS ALAMOS, N.M. — Embedding nanocrystals in glass produces inorganic LEDs that emit in the difficult-to-achieve ultraviolet range. The devices could advance biomedical diagnostics and medicine.

“The electronic states responsible for UV emission are highly energetic and are therefore more susceptible to defect and impurities (typically at the nanocrystal surface). As a result, nanocrystals that are, in principle, capable of emitting in the UV lose their energy to surface states unless suitable passivation techniques are adopted to protect the emitting site from these detrimental effects,” said Sergio Brovelli of Los Alamos National Laboratory.



Embedding nanocrystals in glass provides a way to create UV-producing LEDs for biomedical applications. Courtesy of Los Alamos National Laboratory.

Brovelli and scientists at LANL, in collaboration with researchers at the University of Milano-Bicocca, had these problems in mind when they developed the devices. They combined the chemical inertness and mechanical stability of glass with the properties of electric conductivity and electroluminescence.

In traditional LEDs, light emission occurs at the sharp interface between two semiconductors. The oxide-in-oxide design used by the LANL-led team is different because it allows production of a material that behaves as an ensemble of semiconductor junctions distributed in the glass. The resulting LED is rugged enough to be used in harsh environments, such as for immersion into physiologic solutions or implantation in the body.

“The use of our devices in vivo is one of the potential applications, but before getting there, we will need to optimize the material and engineer the device structure,” Brovelli said. “The fact that the active component of our devices is essentially glass provides superior mechanical properties and, possibly more important, an exceptional chemical inertness.”

This aspect means that the material is not affected by environmental agents that would typically damage organic or colloidal systems if not properly encapsulated. At the same time, it does not contaminate the environment, so it minimizes health risks associated with biocompatible device applications, he said.

The devices' robustness was made possible through a new synthesis strategy that allows fabrication of all-inorganic LEDs via a wet-chemistry approach (a series of simple chemical reactions in a beaker). Importantly, with a very low startup cost, this method is scalable to industrial quantities and is inexpensive.

The material is fully compatible with silicon technology, so it can be miniaturized to fabricate lab-on-a-chip devices for biomedical diagnostics; e.g., as a selective light source for activating fluorescent biomarkers of photoreactive drugs.

“The optimization of material and device structure will be the first steps of our research and will be essential for moving from this proof-of-principle to a real-world technology,” Brovelli said, adding that the researchers also want to exploit the nanostructured glasses' other important features, including photorefractivity, and combine it with their system's electric and optical properties for writing lightguides or micro-UV-LED arrays.

“The oxide-in-oxide motif has demonstrated just a small portion of its true potential, and we want to apply this new concept to other materials of different structure and composition,” he said.

The research appeared online in *Nature Communications* (doi: 10.1038/ncomms 1683).

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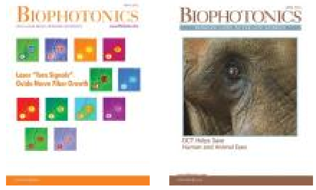

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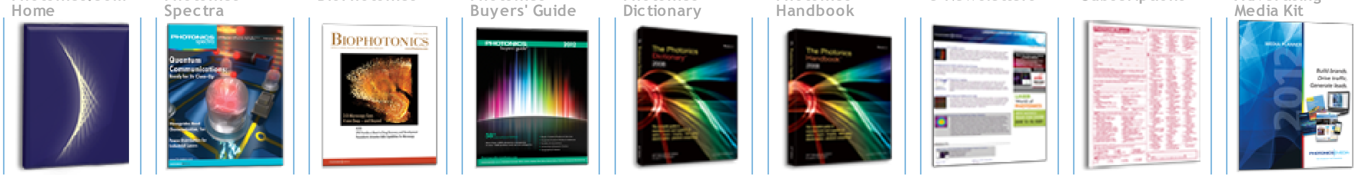

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