VANDERBILT UNIVERSITY

CTTC Center for Technology Transfer & Commercialization

Bright White Light Nanocrystals for LEDs

Summary

A research team lead by Professor Sandra Rosenthal at Vanderbilt University has developed nanocrystals (~2 nm diameter) that emit white light with very high quantum efficiency. This technology would be a viable cost effective candidate for commercial solid-state lighting applications, such as Light Emitting Diodes (LEDs). These nanocrystals were originally discovered by the same group in 2005; a recent breakthrough in post-treatment results in improving fluorescent quantum yield up to ~ 45%.

Addressed Need

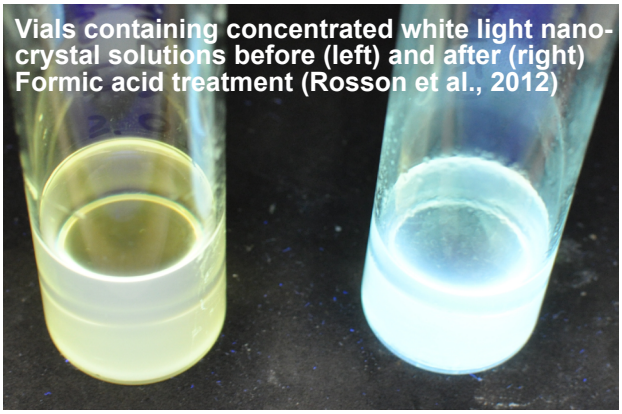
- Increasing cost and energy demands have created a growing need for LEDs as a more efficient replacement for fluorescent and incandescent lighting
- The Department of Energy estimates that adoption of LED lighting in the U.S. by 2027 could reduce lighting electricity demand by 33%, avoid the need for 40 new power plants and deliver savings of about $265 billion[1]
- Currently available technology involves mixing several materials with differing monochromatic emissions to collectively simulate white light. Vanderbilt's technology leads to a much "whiter" light with a single material. This is a more cost effective solution than having to manufacture multiple materials.
- In addition, Vanderbilt's recent processing breakthrough yields materials with fluorescent quantum yields around 45% as compared to previous yields of only 8%

Technology Description

White light emitting nanocrystals were treated with carboxylic acids to enhance the quantum yield of the white light emission without compromising the integrity of the white light. Formic acid treatment demonstrated the highest reported quantum yield increase for white light nanocrystals. Vanderbilt believes that ongoing work will lead to further quantum yield improvements opening the possibility for applications of the nanocrystals in several high-value areas, other than LEDs.

Unique Properties and Competitive Advantages

- White light by single-component as opposed to mixtures of monochromatic materials
- Fluorescence quantum efficiency similar to that of commercial phosphors
- Nanocrystals exhibit broadband emission (420 - 710 nm) without suffering from self-absorption
- Predicted luminous efficiency of ~40 lumens/watt, if developed as a hybrid device with an efficient ultraviolet LED
- Nanocrystals can be encapsulated into many different polymers



Vials containing concentrated white light nanocrystal solutions before (left) and after (right) Formic acid treatment (Rosson et al., 2012)

Intellectual Property Status

- Published patent applications: US20070170418, US20110049442, US20110223425, WO 2011/123349
- PCT applications for post treatments technologies filed in 2012
- Bowers, et al., J. Am. Chem. Soc. 2005, 127, 15378– 15379
- Rosson et al., J. Am. Chem. Soc., 2012, 134 (19), 8006–8009
- Inventor Bio & publications: http://www.vanderbilt.edu/chemistry/faculty/rosenthal.php

1. US Department of Energy; Energy efficiency & renewable energy factsheet DOE/EE-0344, October 2010

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