Chemical Engineering Doctoral Defense

Small Molecule Organic Optoelectronic Devices

School for Engineering of Matter, Transport and Energy

Nathan Bakken

Advisor: Jian Li
Lenore Dai

abstract

Organic optoelectronics include a class of devices synthesized from carbon containing 'small molecule' thin films without long range order crystalline or polymer structure. Novel properties such as low modulus and flexibility as well as excellent device performance such as photon emission approaching 100% internal quantum efficiency have accelerated research in this area substantially. While optoelectronic organic light emitting devices have already realized commercial application, challenges to obtain extended lifetime for the high energy visible spectrum and the ability to reproduce natural white light with a simple architecture have limited the value of this technology for some display and lighting applications. In this research, novel materials discovered from a systematic analysis of empirical device data are shown to produce high quality white light through combination of monomer and excimer emission from a single molecule: platinum(II) bis(methyl-imidazolyl)toluene chloride (Pt-17). Illumination quality achieved Commission Internationale de L'Éclairage chromaticity coordinates and color rendering index ($x = 0.31$, $y = 0.38$) and CRI > 75. Further optimization of a device containing Pt-17 resulted in a maximum forward viewing power efficiency of 37.8 lm/W on a plain glass substrate. In addition, accelerated aging tests suggest high energy blue emission from a halogen free cyclometalated platinum complex could demonstrate degradation rates comparable to known stable emitters. Finally, a buckling based metrology is applied to characterize the mechanical properties of small molecule organic thin films towards understanding the deposition kinetics responsible for an elastic modulus that is both temperature and thickness dependent. These results could contribute to the viability of organic electronic technology in potentially flexible display and lighting applications. The results also provide insight to organic film growth kinetics responsible for optical, mechanical, and water uptake properties relevant to engineering the next generation of optoelectronic devices.

January 6, 2017; 9:00AM; ERC 490