DOE Announces Selections to SSL Core Technologies FOA

The National Energy Technology Laboratory (NETL), on behalf of the US Department of Energy (DOE) is pleased to announce the selection of seven (7) applications in response to Funding Opportunity Announcement (FOA) DE-PS26-04NT42092 entitled *Solid-State Lighting Core Technologies*. The objective of the FOA is to support multiple enabling or fundamental solid-state lighting technology areas for general illumination applications. The seven selections are anticipated to significantly contribute to the goal of the SSL program:

> *By 2015, develop advanced solid-state lighting technologies that, compared to conventional lighting technologies, are much more energy efficient, longer lasting, and cost competitive by targeting a product system efficiency of 50 percent with lighting that accurately reproduces sunlight spectrum.*

The present selections are among the first in a series that may span the next decade. The selections are expected to fill key technology gaps, provide enabling knowledge or data, and represent a significant advancement in the SSL technology base. The knowledge gained from the new selections will contribute to SSL technology maturation, helping to advance SSL from applied research to market acceptance, as targets for efficiency, cost, longevity, stability, and control are demonstrated in a product environment.

The selections are summarized below (subject to negotiation):

Recipient: Boston University
Title: Low-cost Blue/UV LEDs with Very High Photon Conversion and Extraction Efficiency for White Lighting
Project Value: $1,202,693 **Applicant Cost Share:** 20% **Duration:** 36 months
Summary: This project will study a unique approach to growing GaN-based LEDs on thick textured GaN quasi-substrates, using Hydride Vapor Phase Epitaxy (HVPE) instead of more costly Metal-Organic Chemical Vapor Deposition (MOCVD). It is anticipated that the work will demonstrate vastly improved device efficiencies. This is due to the substantial reduction in defect densities normally associated with nitride devices grown on materials of differing lattice constants, such as sapphire. In addition to exploring the potential for large increases in internal quantum efficiency due to the defect density reduction, significant increases in external quantum efficiencies are also possible due to the reduction in natural wave guiding that generally occurs at material interfaces. This imaginative work will address a number of issues plaguing the performance of nitride systems and may enable future breakthroughs in device efficiency and light management.
POC: Maureen Rodgers (617) 353-4365

Recipient: Cabot Superior MicroPowders
Title: Development of Advanced LED Phosphors by Spray-based Processes for Solid State Lighting Applications
Project Value: $4,200,008 **Applicant Cost Share:** 40% **Duration:** 36 months
Summary: Fluorescent lamps that convert deep UV light produced in low pressure plasma discharges into broad spectrum white light characteristically achieve high conversion

efficiencies. Quantum mechanical considerations associated with the relative closeness of frequency (and energy) between blue LEDs and white light currently prevent SSL from achieving the same high conversion efficiencies. This project seeks to overcome this efficiency hurdle by using a unique combination of phosphor activators, hosts, and novel spray-based synthesis techniques. The team expects to demonstrate 60% external quantum efficiency, about twice what the very best devices deliver today. Thus, without any increase in internal quantum efficiency, devices that would exceed 80 LPW could be built using this approach.
POC: Klaus Kunze (505) 563-4380

Recipient: Universal Display Corporation
Title: Novel Low Cost Organic Vapor Jet Printing of Striped High Efficiency Phosphorescent OLEDs for White Lighting
Project Value: $4,000,000 **Applicant Cost Share:** 40% **Duration:** 36 months
Summary: This project builds upon the success of the unique architectural design approach demonstrated in a previous DOE Small Business Innovation Research (SBIR) Phase II project. The previous project focused on producing RGB approach OLEDs for illumination applications. This project will advance a novel manufacturing technology that is capable of economically and reliably manufacturing phosphorescent organic light emitting devices whose performance and utility have been (or will soon be) demonstrated under the SBIR project. The proposed manufacturing technique, organic vapor jet printing, is a significant advancement over conventional ink jet printing techniques insofar as it does not require pre-patterned substrates and solvent (or photo) sensitive molecules. Nor does it require the complex, expensive, and dimensionally sensitive multiple layer "indexing" manufacturing technique currently used for making full color OLED displays. This project will also leverage proven phosphorescent OLED molecules developed under a different Phase II SBIR project to produce them on a prototype organic vapor jet printing line. The resultant devices will perform in excess of 50 LPW.
POC: Janice Mahon (609) 671-0980 x206

Recipient: University of California, San Diego
Title: Development of White-Light Emitting Active Layers in Nitride-Based p-n Heterostructures for Phosphorless Solid State Lighting
Project Value: $1,202,595 **Applicant Cost Share:** 20% **Duration:** 36 months
Summary: Building upon earlier work supported by the DOE at the University of California at San Diego, researchers will use novel, combustion-produced activators to stimulate photonic emissions for otherwise non-radiative relaxation pathways. Early demonstrations of this important concept will be done on thin films using a laser ablation technique, but the potential to use the approach in the design of a practical LED heterostructure will also be explored. This work could have a dramatic impact on traditional nitride devices by substantially improving internal quantum efficiencies by as much as 30%, with virtually no added manufacturing complexity or cost.
POC: Kathleen Johnson (858) 534-0112

Recipient: University of California, Santa Barbara
Title: Surface Plasmon Enhanced Phosphorescent Organic Light Emitting Diodes
Project Value: $1,068,582 **Applicant Cost Share:** 20% **Duration:** 36 months

Summary: Work by leading OLED researchers has repeatedly demonstrated that phosphorescent OLED performance is not limited to 25% of the relaxation pathways that produce photonic emissions, owing to statistical spin of excited states normally associated with singlets. Phosphorescence is routinely used in the laboratory to fabricate phosphorescent OLEDs with performance surpassing 80%. This project will explore novel radiative decay control techniques to harness the energy of triplet states that are chemically and quantum-mechanically different, but functionally similar to currently accepted phosphorescent methods. The three-year project will systematically explore blending of chromophores and different plasmon structures to achieve better efficiencies via enhanced triplet annihilation and utilization.
POC: Guillermo Bazan (805) 893-5538

Recipient: University of Florida
Title: ZnO PN junctions for highly-efficient, low cost light emitting diodes
Project Value: $1,143,172 **Applicant Cost Share:** 20% **Duration:** 36 months
Summary: This ambitious project aims to demonstrate a viable method of synthesizing novel II-VI compound semiconductors based on Zn with Mg (and other) metallic dopants. Intended to demonstrate much better materials properties such as increased p-type concentrations and mobility, enhanced heterojunction constructs, and other effects thought to increase internal quantum efficiency, this project will determine if indeed such a system is a practical alternative to the defect-prone III-V system (currently manufactured but of limited efficacy). Traditionally, these materials were thought to be too brittle and too easily contaminated by environmental constituents such as water to be of value as LEDs. The researchers propose to overcome these limitations using unique alloying technologies.
POC: Aaron Hoover (352) 392-0186

Recipient: University of Southern California
Title: Novel Materials for High-Efficiency White Phosphorescent OLEDs
Project Value: $1,844,086 **Applicant Cost Share:** 27% **Duration:** 36 months
Summary: This imaginative and promising project represents a unique research direction that is based upon sound theoretical and limited experimental demonstration. It seeks to develop a truly novel system of white phosphorescent OLEDs that will directly emit the high efficiency white light essential for application as a general illumination source, as opposed to mixing monochromatic light of different molecular systems. After three years of intensive work, the team will demonstrate white OLEDs exceeding 800 cd/m^2, with lifetimes exceeding 10,000 hours, and efficacy that is expected to eclipse 80 LPW.
POC: Mark Thompson (213) 740-6402