SOLID-STATE LIGHTING:

Solid-State Lighting Patents Resulting from DOE-Funded Projects

As of January 2014, 72 SSL patents have been awarded to research projects funded by the U.S. Department of Energy. Since December 2000, when DOE began funding SSL research projects, a total of 186 patent applications have been submitted, ranging from large businesses (67) and small businesses (65) to universities (45) and national laboratories (9).

Primary Research Organization	Titles of Patent Applications (Bold indicates patents that were granted)	
Agiltron, Inc.	• **Optoelectronic Device With Nanoparticle Embedded Hole Injection/Transport Layer**	• One other patent application filed
Applied Materials, Inc.	• Method and Apparatus for Inducing Turbulent Flow of a Processing Chamber Cleaning Gas • Methods for Improved Growth of Group III Nitride Semiconductors	• Methods for Improved Growth of Group III Nitride Buffer Layers • Multiple Complementary Gas Distribution Assemblies
Arkema, Inc.	• OLED Substrate Consisting of Transparent Conductive Oxide (TCO) and Anti-Iridescent Undercoat	• Chemical Vapor Deposition Using N,O Polydentate Ligand Complexes of Metals
Boston University	• **Optical Devices Featuring Textured Semiconductor Layers** • Formation of Textured III-Nitride Templates for the Fabrication of Efficient Optical Devices	• Formation of Textured III-Nitride Templates for the Fabrication of Efficient Optical Devices • Nitride LEDs Based on Flat and Wrinkled Quantum Wells
Cree, Inc.	• **Light Emitting Diode with Porous SiC Substrate and Method for Fabricating** • **LED Package Element with Internal Meniscus for Bubble-Free Hallow Floating Lens Placement** • **Light Emitting Diode with High Aspect Ratio Sub-Micron Roughness for Light Extraction and Methods of Forming**	• **Expandable LED Array Interconnect** • Ultra-Thin Ohmic Contacts for P-type Nitride Light Emitting Devices • High Reflectivity Mirrors and Method for Making Same • High Reflectivity Mirrors and Method for Making Same • LED Structure with Enhanced Mirror Reflectivity
Crystal IS, Inc.	• Growth of Large Aluminum Nitride Single Crystals with Thermal-Gradient Control	• Growth of Large Aluminum Nitride Single Crystals with Thermal-Gradient Control
Dow Corning	• Four patent applications filed	
Eastman Kodak	• **Ex-Situ Doped Semiconductor Transport Layer** • **Doped Nanoparticle-Based Semiconductor Junction** • **Device Containing Non-Blinking Quantum Dots**	• **Light-Emitting Nanocomposite Particles** • Making Colloidal Ternary Nanocrystals
Fairfield Crystal Technology	• Method and Apparatus for Aluminum Nitride Monocrystal Boule Growth	
GE Global Research	• **Light-Emitting Device with Organic Electroluminescent Material and hotoluminescent Materials** • **Luminaire for Light Extraction from a Flat Light Source** • **Mechanically Flexible Organic Electroluminescent Device with Directional Light Emission** • **Organic Electroluminescent Devices and Method for Improving Energy Efficiency and Optical Stability Thereof** • **Series Connected OLED Structure and Fabrication Method** • **Organic Electroluminescent Devices Having Improved Light Extraction**	• **Electrodes Mitigating Effects of Defects in Organic Electronic Devices** • **OLED Area Illumination Source** • **Blue-Green and Green Phosphors for Lighting Applications** • **Lighting System with Thermal Management System** • **Lighting System with Heat Distribution Face Plate** • Lighting System with Thermal Management System Having Point Contact Synthetic Jets • Materials for Optoelectronic Devices • Materials for Optoelectronic Devices • Hybrid Electroluminescent Devices • Eight other patent applications filed

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GE Lighting Solutions	• **Novel Green Emitting Phosphors and Blends Thereof** • Phosphor Suspended in Silicone, Molded/Formed and Used in a Remote Phosphor Configuration • One other patent application filed	
General Electric Company	• **Color Stable Manganese-Doped Phosphors** • **Alkaline and Alkaline Earth Metal Phosphate Halides and Phosphors** • **Coated Phosphors, Methods of Making Them, and Articles Comprising the Same**	• **Kimzeyite Garnet Phosphors** • Color Stable Phosphors • Alkaline Earth Borate Phosphors
Georgia Tech Research Corporation	• One patent application filed	
International Technology Exchange	• One patent application filed	
KLA-Tencor	• **Scattered Light Separation** • Substrate Inspection	
Lawrence Berkeley National Laboratory	• **Carbon Nanotube Polymer Composition and Devices** • **Organic Light Emitting Diodes with Structured Electrodes**	
Lehigh University	• **Gallium Nitride-Based Device and Method** • Staggered Composition Quantum Well Method and Device • Staggered Composition Quantum Well Method and Device	
Light Prescriptions Innovators	• **Optical Manifold for Light-Emitting Diodes** • **Optical Manifold for Light-Emitting Diodes** • **Optical Manifold**	• **Wide Band Dichroic-Filter Design for LED-Phosphor Beam Combining** • **Optical Device for LED-Based Lamp** • Three other patent applications filed
Lightscape Materials Inc.	• **Oxycarbonitride Phosphors and Light Emitting Devices Using the Same** • **Carbonnitride Based Phosphors and Light Emitting Devices Using the Same** • **Silicon Carbidonitride Based Phosphors and Lighting Devices Using the Same**	• Oxynitride-Based Phosphors and Light Emitting Devices Using the Same • Carbonitride-Based Phosphors • Nitride and Oxynitride Based Phosphors and LED Devices Using the Same • Carbonitride- and Carbonitridophosphide-Based Phosphors and Lighting Devices Using the Same
Maxdem Incorporated	• **Polymer Matrix Electroluminescent Materials and Devices**	
Nanosys	• **Nanocrystal Doped Matrices**	
National Renewable Energy Laboratory	• High Bandgap III-V Alloys for High Efficiency Optoelectronics • High Bandgap III-V Alloys for High Efficiency Optoelectronics	
OSRAM Opto Semiconductors, Inc.	• **Integrated Fuses for OLED Lighting Device** • **Novel Method to Generate High Efficient Devices, Which Emit High Quality Light for Illumination** • **Polymer and Small Molecule Based Hybrid Light Source** • **Thermal Trim for a Luminaire**	• OLEDs with Phosphors • Novel Method to Generate High Efficient Devices, Which Emit High Quality Light for Illumination • Polymer Small Molecule Based Hybrid Light Source • One other patent application filed
OSRAM SYLVANIA Inc.	• **Ceiling Mounted Luminaire** • Removable Solid State Light Source for Ceiling Mounted Luminaire • Thermal Trim for a Luminaire • Thermal Trim for a Luminaire	• Apparatus Incorporating an Optically Transmitting Circuit Board • Arrangement of Solid State Light Sources and Lamp Using Same • One other patent application filed

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Pacific Northwest National Laboratory	• **OLED Devices** • Organic Materials with Phosphine Sulphide Moieties Having Tunable Electric and Electroluminescent Properties	• Organic Materials with Tunable Electric and Electroluminescent Properties
Philips Electronics North America	• Four patent applications filed	
Philips Lumileds Lighting	• **Zener Diode Protection Network in Submount for LEDs Connected in Series** • LED Module with High Index Lens	• Molded Lens Incorporating a Window Element • One other patent application filed
PhosphorTech Corporation	• **Light Emitting Device Having Selenium-Based Fluorescent Phosphor** • **Light Emitting Device Having Silicate Fluorescent Phosphor**	• **Light Emitting Device Having Sulfoselenide Fluorescent Phosphor** • **Light Emitting Device Having Thio-Selenide Fluorescent Phosphor**
Purdue University	• Metallized Silicon Substrate for Indium Gallium Nitride Light-Emitting Diode • Metallized Silicon Substrate for Indium Gallium Nitride Light-Emitting Diode	• Process for Fabricating III-Nitride Based Nanopyramid LEDs Directly on a Metallized Silicon Substrate
Rensselaer Polytechnic Institute	• Method of Fabricating An Ohmic Contact to N-Type Gallium Nitride • Free-Standing Mounted Light Emitting Diodes for General Lighting	
Research Triangle Institute	• Long-Pass Optical Filter Made from Nanofibers • Stimulated Lighting Devices • Reflective Nanofiber Lighting Devices • Photoluminescent Nanofiber Composites, Methods and Fabrication, and Related Lighting Devices	• Color Tunable Lighting Devices and Methods for Tuning Color Output of Lighting Devices • Lighting Devices with Color-Tuning Materials and Methods for Tuning Color Output of Lighting Devices • Lighting Devices with Color-Tuning Materials and Methods for Tuning Color Output of Lighting Devices
Sandia National Laboratories	• **Cantilever Epitaxial Process** • **Nanowire-Templated Lateral Epitaxial Growth of Non-Polar Group III Nitrides**	
Sinmat, Inc.	• **High Light Extraction Efficiency Solid State Light Sources** • Chemical Mechanical Fabrication (CMF) for Forming Tilted Surface Features	
Soraa, Inc.	• Two patent applications filed	
Universal Display Corporation	• **Binuclear Compounds** • **Organic Light Emitting Device Structure for Obtaining Chromaticity Stability** • **Organic Light Emitting Device Structure for Obtaining Chromaticity Stability** • **Organic Light Emitting Device Architecture for Reducing the Number of Organic Materials** • **Organic Light-Emitting Devices for Illumination** • **Intermediate Connector for Stacked Organic Light Emitting Devices** • **White Phosphorescent Organic Light Emitting Devices**	• Stacked OLEDs with a Reflective Conductive Layer • Organic Light Emitting Device with Conducting Cover • General Bus Line Design Rules for Large-Area OLED Lighting • Light Extraction Blocks for Thin Form Factor OLED Lighting with Improved Power Efficacy • Novel Host Compounds for Red Phosphorescent OLEDs • Precision OVJP Nozzle-Substrate Spacing System • Precision OVJP Nozzle-Substrate Spacing System
University of California, San Diego	• Rare Earth-Activated Nitrides for Solid State Lighting Applications • Rare Earth-Activated Aluminum Nitride Powders and Method of Making	• Light Emitting Diode Based on Multiple Double Heterostructures (Multiple Quantum Wells) with Rare Earth Doped Active Regions

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University of California, Santa Barbara	• **Plasmon Assisted Enhancement of Organic Optoelectronic Devices** • **Horizontal Emitting, Vertical Emitting, Beam Shaped, Distributed Feedback (DFB) Lasers by Growth Over a Patterned Substrate** • **Single or Multi-Color High Efficiency Light Emitting Diode (LED) by Growth Over a Patterned Substrate** • **Enhancing Performance Characteristics of Organic Semiconducting Films by Improved Solution Processing**	• Optoelectronic Devices with Embedded Void Structures • Silicone Resin Encapsulants for Light Emitting Diodes • Semiconductor Micro-Cavity Light Emitting Diode • Nanowire-Polymer Composite Electrodes • Selective Dry Etching of N-Face (Al,In,Ga)N Heterostructures • Selective Dry Etching of N-Face (Al,In,Ga)N Heterostructures • Two other patent applications filed
University of Florida Research Foundation	• Stable and All Solution Processable Quantum Dot Light-Emitting Diodes	
University of Michigan	• Gas Cushion Control of OVJP Print Head Position • Ultrabright Fluorescent OLEDs Using Triplet Sinks	
University of North Texas	• Organic Light-Emitting Diodes from Homoleptic Square Planar Complexes • Two other patent applications filed	
University of Southern California	• **Fluorescent Filtered Electrophosphorescence** • **Fluorescent Filtered Electrophosphorescence** • **OLEDs Utilizing Macrocyclic Ligand Systems** • **Organic Vapor Jet Deposition using an Exhaust** • **Phenyl and Fluorenyl Substituted Phenyl-Pyrazole Complexes of Ir**	• **Organic Light Emitting Device Having Multiple Separate Emissive Layers** • Materials and Architectures for Efficient Harvesting of Singlet and Triplet Excitons for White Light Emitting OLEDs • Low Index Grids (LIG) to Increase Outcoupled Light from Top or Transparent OLED • Stable Blue Phosphorescent Organic Light Emitting Devices • One other patent application filed
Yale University	• Conductivity Based Selective Etch for GaN Devices and Applications Thereof	

For More Information
For more information on the DOE SSL Project Portfolio, see ssl.energy.gov/projects.html.

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