P. Morgan Pattison
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Experience

Solid State Lighting Services, Inc. **November 2007 - Present**
Founder/President- Provide technical, strategic, and market expertise in the areas of LEDs, OLEDs, Lighting, Solid State Lighting (SSL), displays, and optoelectronic materials and devices. LED device, lighting, and materials product development. Horticultural lighting research and strategy. Light pollution measurement, evaluation, and mitigation. LED and lighting product failure and reliability evaluation. Human physiological responses to light. Scout and evaluate new technologies for investment.

U.S. Department of Energy **January 2006 – November 2007**
National Energy Technology Laboratory, Morgantown WV
Project Manager- Managed DOE funded R&D projects in SSL including LED and OLED lighting technologies. Managed solicitation and selection of new funded R&D projects. Identified priority areas of research necessary for advancement of SSL efficiency, performance, and price.

University of California, Santa Barbara **September 2000 – January 2006**
Graduate Student Researcher- Doctoral thesis research under Professor Shuji Nakamura (Nobel Prize in Physics 2014) on GaN based micro-cavity light emitting diodes. Research included: epitaxial structure design and growth by MOCVD, semiconductor process development, materials characterization, and electro-optical device characterization. Additional areas of research included UV LEDs, vertical cavity surface emitting laser (VCSEL), and edge emitting laser diodes.

Cymer Laser, San Diego **November 1996 – May 2000**
Laser Test Engineer- Tested and developed test methodology for production and prototype KrF and ArF excimer lasers used in deep UV photolithography for manufacturing of advanced semiconductor products. Testing included optical characterization and full system troubleshooting. Test development of new electrical and optical test methodologies to improve test cycle, Labview automation of test procedures, and development of test documentation.

Education

Ph.D. Materials Science, Electronic and Photonic Materials
University of California, Santa Barbara, 2006
Thesis: *Fabrication and Characterization of Gallium Nitride Based Micro-Cavity LEDs*
M.S. Electrical Engineering, Electronics and Photonics
University of California, Santa Barbara, 2003
B.S. Electrical Engineering, Electronic Devices and Materials
University of California, San Diego, 1996

Expertise

Optoelectronic materials and devices, lighting, LED, OLED, R&D and technology evaluation, LED-OLED-Quantum Dot display technology, SSL product evaluation and selection, LED lighting product development, R&D Management, technology roadmapping, technical meeting moderation, technical writing, IP evaluation, trial expert witness, lighting color evaluation and selection, advanced lighting performance evaluation, Energy Star LED lighting testing, photometric characterization and testing, R&D Management, Federal R&D funding processes, R&D Proposal review and evaluation, ESCO contracts and performance measurement & verification (M&V), horticultural lighting, wildlife responses to light, human physiological responses to light

Accreditations, Affiliations, and Professional Societies

Oregon State University, Civil and Construction Engineering, Courtesy Faculty
Lighting Certified (LC) by National Council on Qualifications for Lighting Professionals
Member - Illuminating Engineering Society of North America (IESNA)
    Member – IES Horticultural Lighting Committee
    Chair – Outdoor Nighttime Environments (ONE) Committee
Member - International Society of Horticultural Scientists (ISHS)
Member – International Dark-Sky Association (IDA)
Member – International Society for Optics and Photonics (SPIE)
Member – American Society of Agricultural and Biological Engineers (ASABE)
Project Management Professional (PMP) *Lapsed,* Project Management Institute (2006)
U.S. Government Contracting Officer's Representative (COR) (2006)

Leadership

Senior Technical and Strategic Advisor to DOE SSL R&D Program
Lead writer of DOE SSL R&D Opportunities, R&D Plan, and Multi-Year Program Plan
Technical content supervisor of annual DOE SSL R&D Workshop
Manage organization of DOE SSL topical R&D meetings on: LED devices and materials, OLEDs, luminaire integration, roadway lighting, germicidal ultraviolet (UV) LEDs, human physiological responses to light, domesticated and wild animal responses to light, roadway and area lighting, and horticultural lighting
New business creation/development –*Action Spectrum, Ultra-Yield Solutions, Guidance LED, Zuli, Canvas, Intellilight/Next, SSLS, Inc., Diel Lighting Science*
Scientific Advisory Board member to *GLASE (Greenhouse Lighting and System Engineering)*, NYSERDA funded controlled environment agriculture R&D program
Technical Advisory Committee of Resource Innovation Institute
Advisory Board Member of *Phosphor Global Summit* annual meeting
Advisor to *Cyclotron Road* – Clean Technology Incubator at Lawrence Berkeley National Lab
Project sponsor for Senior Design Course at UCSB (2011-2012)

1. Design and development of spectro-goniophotomoter
2. Design and development of smartphone light controller (co-founder and original board member of resulting company now called *Zuli*)

Designed, fabricated, and characterized world's first gallium nitride microcavity LED
Fabricated and characterized world's first gallium nitride semipolar LED

Publications

Minimizing Ecological Impacts of Marine Energy Lighting. Reilly, C. E., Larson, J., Amerson, A. M., Staines, G. J., Haxel, J. H., & Pattison, P. M. (2022). *Journal of Marine Science and Engineering*, *10*(3), 354.

Department of Energy SSL Manufacturing Status and Opportunities (2022)

Photon Efficacy in Horticulture. Kusuma, P, Pattison, PM, Bugbee, B. (2021) Chapter 7 in *Plant Factory: Basics, Applications and Advances*

A Review of Human Physiological Responses to Light: Implications for the Development of Integrative Lighting Solutions. Vetter, C, Pattison, PM, Houser, K, Herf, M, Phillips, AJK, Wright, KP, Skene, DJ, Brainard, GC, Boivin, DB, Glickman, G. (2021) *Leukos*

DOE 2020 LED Manufacturing Supply Chain. Lee, K, Nubbe, V, Rego, B, Hansen, M, Pattison, M. *U.S. DOE Lighting R&D Program.* July 2021.

Energy Savings Potential of SSL in Agricultural Applications. Lee, K, Elliott, C, and Pattison, PM. *U.S. DOE Lighting R&D Program.* June 2020.

From physics to fixtures to food: current and potential LED efficacy. Kusuma, P, Pattison, PM, and Bugbee, B. (2020) *Horticultural Research.* 7, 56.

What's next for LEDs. Pattison, PM (2019) *Electroindustry.* March/April 2019.

Building the evidence outside the lab. Pattison, PM (2018) *Lighting Design & Application.* December

LEDs for photons, physiology and food. Pattison, PM, Tsao, JY, Brainard, GC, Bugbee, B. (2018) *Nature.* 563, 493-499.

LEDs for Horticulture: More than Meets the Eye. Pattison, PM. (2018) *Lighting Design & Application.* August.

LED lighting efficacy: Status and directions. Pattison, PM, Hansen, M, Tsao, JY. (2018) *Comptes Rendus Physique.* 19, 134-145.

Energy Savings Potential of SSL in Horticultural Applications. Stober, K, Lee, K, Yamada, M, and Pattison, PM. *U.S. DOE Lighting R&D Program.* December 2017.

Department of Energy Solid State Lighting R&D Opportunities/Plan, *lead author* (2022, 2019, 2018, 2017, 2016, 2015)

Light-emitting diode technology status and directions: opportunities for horticultural lighting. Pattison, PM, Tsao, JY, Krames, MR. (2016) *Acta Horticulturae*. 1134, 413-426.

Status of SSL Product Development and Future Trends for General Illumination. Katona TM, Pattison PM, Paolini S. (2016) *Annual Review of Chemical and Biomolecular Engineering* 7 (1).

The Blue LED Nobel Prize: Historical context, current scientific understanding, human benefit. Tsao, J, Han, J, Haitz, R, Pattison, PM. (2015) *Annalen der Physik* 527, No. 5–6, A53–A61.

Department of Energy SSL R&D Multi-Year Program Plan (2008-2014)

Department of Energy SSL Manufacturing Roadmap (2009-2014)

Gallium nitride based microcavity light emitting diodes with 2 lambda effective cavity thickness. Pattison, P. M., David, A., Sharma, R., Weisbuch, C., DenBaars, S., & Nakamura, S. (2007). *Appl. Phys. Lett*, *90*, 031111.

First-moment analysis of polarized light emission from InGaN/GaN light-emitting diodes prepared on semipolar planes. Masui, H., Baker, T. J., Sharma, R., Pattison, P. M., Iza, M., Zhong, H., Nakamura, S., & DenBaars, S. P. (2006). *Japanese journal of applied physics*, *45*(9L), L904.

Gallium nitride based micro-cavity light emitting diodes emitting at 498 nm. Pattison, P. M., Sharma, R., David, A., Waki, I., Weisbuch, C., & Nakamura, S. (2006). *Physica Status Solidi (a)*, *203*(7), 1783-1786.

Demonstration of a semipolar (10 (1) over-bar (3) over-bar) InGaN/GaN green light emitting diode. Sharma, R., Pattison, P. M., Masui, H., Farrell, R. M., Baker, T. J., Haskell, B. A., Wu, F., DenBaars, S.P., Speck, J.S., & Nakamura, S. (2005). *Applied Physics Letters*, *87*(23).

Micro cavity effect in GaN-based light-emitting diodes formed by laser lift-off and etch-back technique. Fujii, T., David, A., Schwach, C., Pattison, P. M., Sharma, R., Fujito, K., Margalith, T., DenBaars, S.P., Weisbuch, C., & Nakamura, S. (2004). *Japanese journal of applied physics*, *43*(3B), L411.

292 nm AlGaN single-quantum well light emitting diodes grown on transparent AlN base. Hanlon, A., Pattison, P. M., Kaeding, J. F., Sharma, R., Fini, P., & Nakamura, S. (2003). *Japanese journal of applied physics*, *42*(6B), L628.

Higher efficiency InGaN laser diodes with an improved quantum well capping configuration. Hansen, M., Piprek, J., Pattison, P. M., Speck, J. S., Nakamura, S., & DenBaars, S. P. (2002). *Applied physics letters*, *81*(22), 4275-4277.

Presentations

IES Raleigh Section "Horticultural Lighting – A Growing Opportunity", IES Street and Area Lighting Conference 2022, National Park Service Science and Technology – Skyglow Measurements at Channel Islands National Park 2022, UCSB Nitride Seminar 2022, International SSL Alliance 2021 General Assembly, The Limits of Food Production – Vertical Farming 2021, Horticann 2020, U.C. Davis Energy and Efficiency Institute, California Energy Administration, 2020 DOE Lighting R&D Workshop, Charleston Catholic High School STEM Seminar, East Tennessee State University Physics and Astronomy Seminar, IES Rocky Mountain Section – CU Boulder, 2019 DOE SSL R&D Workshop, Harvard ES-173 Guest Lecture, U.S. DOE Building Technologies Office Brown Bag Seminar, U.C. Santa Barbara Nitrides Seminar 2018, Phosphor Global Summit 2018, West Virginia State University – Biology Seminar, East Tennessee State University Entrepreneur Club 2018, IES Aviation Lighting Committee Meeting 2017 (Best Technical Paper), ICCEA Panama 2017, NCERA 101 Controlled Environment Agriculture meeting, DOE SSL R&D Workshop 2017, The College of New Jersey Physics Colloquium, DOE SSL R&D Workshop 2017, NREL 2016, Harvard University Engineering Seminar, LightSym 2016, DOE SSL R&D Workshop 2016, DOE SSL Technology development Workshop 2015, DOE SSL R&D Workshop 2015, IDTechX Internet of Things Applications, Phosphor Global Summit 2014, International Conference on Nitride

Semiconductors 2013, IES Illuminate Philadelphia 2012, Strategies in Light 2012, Energy Efficiency Expo 2011, Tennessee Association of Physical Plant Administrators 2011, East Tennessee State University Faculty Development Sustainability Seminar 2011, LED Discovery 2010, Think Tomorrow Today 2008, International Conference on Nitride Semiconductors 2005, International Symposium on Blue Lasers and Light Emitting Diodes 2004, Fall Materials Research Society 2001.

Patents

Technique for growth and fabrication of semipolar (Ga, Al, In, B) N thin films, heterostructures, and devices. #9793435, #9231376, #8686466, #7846757, #10529892

Lighting unit having lighting strips with lighting elements and a remote luminescent material. #8491165

Lighting unit with heat dissipating chimney #8360607

Lighting unit with indirect light source #8684566 B2

System for monitor and control of equipment. #9432210

Semiconductor light emitting device #8227820, #8643036

Etching technique for the fabrication of thin (Al, In, Ga) N layers. #7795146

Semiconductor micro-cavity light emitting diode. Application # 11/510,240 (abandoned)