ISA
International SSL Alliance

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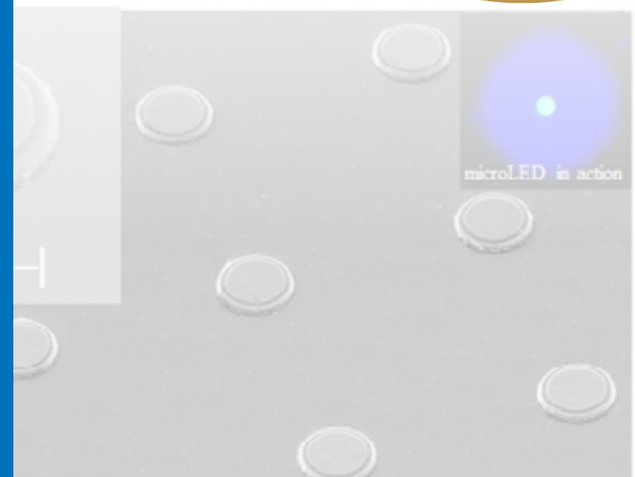

Solid state lighting (SSL) is a new successful lighting revolution after incandescent lamp and fluorescent lamp, not only it can provide low carbon and comfortable lighting, but also it is an important path to improve people's livelihood and to achieve sustainable development. ISA has been seeking to foster and stimulate this great lighting revolution, and is proud of being able to contribute to the promotion of this industry and its sustainable development.

The course from creation, innovation to startup of SSL and to the formation of an influential industry and final recognition and acceptance worldwide is centering on the cultivation and building of the "ecosystem" of SSL. This "ecosystem" includes the government policy makers, manufacturers, designers, standard setters, inspectors, marketing, ultimate users, etc. Building of this "ecosystem" requires the joint efforts of tens of thousands of individuals and collectives, and the cultivation process needs the government's strategic guidance, policy orientation, project organization, incentive measures, financial support, etc., as well as grasp of nodes and accurate efforts.

Without the deep insight and foresight of scientists for the unknown of the humankind, assiduous work and fortitudinous spirit of engineers and the risk spirit and unremitting efforts of entrepreneurs, we cannot enjoy the well-being brought by SSL. Also, without the contributions of relevant government departments to this "ecosystem" and their support, guidance and service, this achievement cannot be applied universally so quickly. When we review and declare this history, we should remember the outstanding individuals, groups and organizations creating this history.

Just for the above reason, ISA started to launch the "Global SSL Award of Outstanding Achievement" (AOA) from 2013 to pay the utmost respect and recognition to these outstanding contributors, and also to inspire more and more individuals and groups to devote to this great cause, to move forward the history with their knowledge and innovation, to create more exciting results, to make contributions to human beings and to benefit all mankind.

Jianlin Cao

Jianlin Cao
President of ISA

ISA Introduction

ISA is a non-for-profit international organization consists of regional alliances, association/society, leading companies and renowned universities in global Solid State Lighting (SSL) field.

The Business of ISA members have covered the whole SSL value chain of upstream, middle stream and downstream of global SSL industry such as epitaxy, packaging application, materials and equipment, design system integration and testing etc.

The currently ISA 77 members, representing more than 4000 individuals & organizations includes major players (such as Signify, Osram, Smsung, GE Lighting, Cree, Veeco, AIXTRON etc.). The output of which covers more than 70% that of global SSL industry.

The ISA Board of Advisers consists of leading experts and academic "Founder" level experts, such as the inventors of blue LED, yellow LED, Red LED, and OLED. Amongst Professor Shuji Nakamura, the Laureate of Nobel Prize in Physics in 2014, is the Co-Chair of ISA Board of Advisors (BOA) and Professor Hiroshi Amano, the Laureate of the Nobel Prize in Physics in 2014 is the member of ISA BOA.

The major works of ISA are: provide services to promote the development and application of global SSL, standardization, annually Global SSL Industry Report, annually SSL Awards, promote international, national and regional cooperation on SSL, etc.

The Mission of ISA

Cooperation with the global resources and efforts, ISA looks forward to fostering a more appropriate "eco-system" for the health development of the global SSL and its application. Echo the needs of the society with more added value services to ISA members. Strive to improve people's living and contribute a sustainable human society.

Global SSL Award of Outstanding Achievement

Mission statement

The "Global SSL Award of Outstanding Achievement" aims to recognize outstanding achievement by individuals or organizations to global SSL development in particular for Science and Technology & Standardization & Policy & Application & Industry. This award is one of the highest honor to recognize contribution and achievement in global SSL field.

Categories of the Awards

1. Award of Outstanding Achievement on SSL Science and Technology
2. Award of Outstanding Achievement on SSL Standardization
3. Award of Outstanding Achievement on SSL Policy
4. Award of Outstanding Achievement on SSL Application
5. Award of Outstanding Achievement on SSL Industry

Recurrence

The Award will be made annually and continue identifying a certain number of outstanding achievements according to the nomination. The Council of Management of ISA reserves the right not to make an award in any year or to make more than one.

Any organization in the SSL industry can nominate.

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Global SSL Award of Outstanding Achievement

Professor Martin David Dawson

Biography

Professor Martin D. Dawson is the Director of Research at the University of Strathclyde's Institute of Photonics https://www.strath.ac.uk/science/physics/instituteofphotonics/ , an internationally-recognized research center which he helped establish 25 years ago. Throughout this time he has been the Institute's principal research leader and technical strategist, introducing and overseeing almost all of its research themes and programs (dilute and wide bandgap nitride semiconductors; SESAM mode-locking of solid-state lasers; diamond photonics; optically-pumped semiconductor lasers; micro-LEDs; optogenetics; visible light communications; micro-transfer printing for heterogeneous integration…) and mentoring and supporting its staff and students at all levels. The current staff complement of the Institute are either his former students or post-docs (Hastie, Herrnsdorf, Laurand, Gu) or external appointments he has deliberately attracted, integrated and supported (Watson, Kemp, Mathieson, Strain, Hurtado, Caspani).

Since 2012 he is also the inaugural Head and Scientific Director of the UK's only Fraunhofer research center, the Fraunhofer Centre for Applied Photonics (Fh-CAP), https://www.fraunhofer.co.uk/en/AboutFraunhoferCAP.html a dedicated innovation organization in the Fraunhofer network (Europe's largest applications-oriented research organization) operating under the 'professorial director' model pioneered in Germany. He has appointed and mentored all of the technical staff in Fraunhofer CAP and defined and developed its technical remit, which includes a leading technology development position in the UK's National Quantum Technology Program. These two research centers are co-located in Glasgow, UK, and together employ more

than 100 staff and students and have a combined annual R&D turnover of ~£10M, most of which is generated by externally-won competitive project funding from UK government and/or industry. Both centers have a remit to engage closely with industry, and together they have to date had funded R&D collaborations with over 150 companies, ranging from small-to-medium size enterprises (SMEs) to major multinationals.

Dawson received his BSc (First Class Honours) and PhD degrees in Physics from Imperial College London in 1981 and 1985, respectively, and subsequently worked in academia and industry in the USA (North Texas State University, University of Iowa) and UK (Sharp Laboratories of Europe Ltd.) before joining the University of Strathclyde in 1996. His work in the USA involved development of mode-locked dye laser technology which was commercialized by Coherent and Quantronix. At Sharp he performed extensive fundamental studies of AlInGaP/GaAs red-emitting semiconductors for applications in light-emitting diodes and laser diodes, and he also became one of the earliest researchers in the UK and internationally (1994/1995) to study gallium nitride, both collaboratively with colleagues at the University of Nottingham and via early access to devices from Nichia.

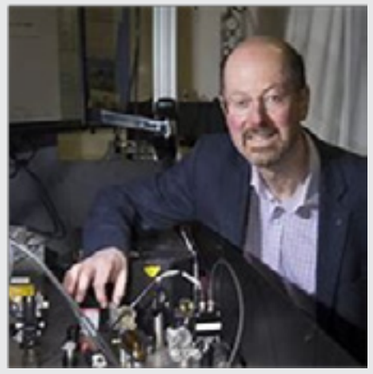
Dawson has published over 900 refereed journal and conference papers, and he has been closely involved in the founding of several new companies (Compound Semiconductor Technologies, Photonix, Kamelian, mLED, NeuroVLC) either based directly on, or having strong input from, his work. He has supported these and many other industrial collaborations through foresighted and imaginative use-inspired basic research (much of this involving his leadership of major, multi-disciplinary, publically-funded research partnerships), underpinning collaborative research, proof of principle and prototype demonstration work, the filing and licensing of patents and transfer of know-how, and the employment of his (~40 to date) PhD graduates. He has filed and assigned patents to organizations including mLED (US7598149B2), Kamelian (US20020933730, US2002093731, US2002080844), Element Six Ltd (US9034200),

and Facebook (US10,694,953, US7598149B2). He holds fellowships of the IEEE, Optical Society of America, Institute of Physics (IOP) and Royal Society of Edinburgh (Scotland's National Academy) and he has received a number of awards for his work including Gabor Medal and Prize (Institute of Physics, 2016), Aron Kressel Award (IEEE Photonics Society, 2016) and Nick Holonyak Jr Award (Optical Society of America, 2021), the latter being "For wide-ranging contributions to the development and application of III-V semiconductor devices especially including gallium nitride micro-LEDs and optically-pumped semiconductor lasers". He has been highly active in professional service, including for IOP, OSA, Royal Society, Royal Society of Edinburgh, Rank Prize Funds, IEEE Photonics Society. He has served the IEEE Photonics Society (IPS), for example, as VP Conferences, Member of the Program Chairs' Committee for its annual IEEE Photonics Conference and Member of its Board of Governors, and he has received the IPS Distinguished Service Award (2021) "For sustained leadership in society governance from local to international level, with special distinction in conference organization and strategy".

On arrival at Strathclyde in 1996, Dawson established MOCVD growth of gallium nitride, the first such capability in the UK to involve a dedicated new growth system (Aixtron), and combined this with the introduction of inductively-coupled plasma dry etching, then a novel technique. The latter has been a mainstay in his research over the past 25 years, permitting processing of hard optical and optoelectronic materials (gallium nitride, sapphire, silicon carbide, diamond) whose individual characteristics and combined capabilities he has been prominent in exploiting. In particular this has facilitated advanced microfabrication of gallium nitride optoelectronic devices but also of the growth substrates (sapphire, SiC) for such structures, permitting, for example, substrate-based micro-optics to be fabricated in registry to gallium nitride light-emitting devices. He has also been prominent in hybrid and heterogeneous integration of gallium nitride devices with such diverse materials as diamond, colloidal semiconductor quantum dots, semiconductor nanoplatelets, and organic semiconductors, using techniques such as micro-transfer printing and ink-jet printing. These capabilities have been crucial in his pioneering work on gallium nitride micro-LEDs.

Outstanding Achievements Brief

Martin Dawson is a widely-acknowledged international pioneer of micro-LED technology (micron-sized-pixel light emitting diode arrays based particularly on gallium nitride semiconductors), an electronic visual display technology now emerging extremely rapidly to mass-market commercialization, based on its very fast response time (ns), high resolution (few microns) and high brightness (up to >106 cd/m2), combined with versatility and scalability from wearables to large area displays.



Dawson began his work in micro-LEDs in 2001 when, with H.X. Jiang and Jingyu Lin (then at Kansas State University, now at Texas Tech) and A.V. Nurmikko (Brown University), he contributed prominently to the founding of the field. In the ensuing two decades he has been arguably the most imaginative and extensive contributor worldwide to this research field, reporting his research in over 250 research and conference papers, in review articles , dedicated paper collections and books, and in major talks at national and international meetings, which includes invited talks at all four of the major international displays conferences, SID Display Week, ICDT, IMID and IDW.

In particular he was the first to recognize, in 2003/04, the implications of micro-LEDs not only as an important new display technology with the advantageous characteristics noted above, but also as a novel digital light projection technology, a vision which he and his colleagues and collaborators have exploited extensively. Much of this vision was based on his early recognition (reported 2008) of the compatibility of the technology with CMOS driving electronics and solid-state cameras and single-photon counting systems and of the opportunities enabled by this. Three particularly important strands have emerged from this vision:

1. The importance of micro-LEDs for optical data communications, which includes optical wireless communications (OWC) in various environments, such as in atmosphere, underwater and in space, and guided wave optical communications (GWOC) in such as polymer optical fibers (POF), polymer waveguide backplanes (PWBs) and short-wavelength photonic integrated circuits (SW-PICs). This is based on the specific (UV/visible) wavelength coverage of the devices and the high modulation bandwidths and compatibility with high-level data encoding schemes of individual micro-LED pixels, leading to data rates approaching 10Gb/s per pixel (associated work was awarded the IEEE Photonics Technology Letters Best Paper award in 2019). This is further augmented by the datacom characteristics of arrays of the devices, and their 'data through display' compatibility with such modes of operation as 'digital-to-light' discrete power level stepping, MIMO (Multiple Input Multiple Output) and optical camera communications. The overall picture here is of a display technology which can

sense, interact with and communicate with its environment, which is a novel concept poised for major further impact.

2. The technology is capable of being a light fidelity (LiFi) - compatible smart lighting technology in its own right, capable of such advanced functions as object location, tracking and imaging, as well as optical wireless communications, facilitated by the direct compatibility of the technology with highly-sophisticated control electronics. These realizations have broadened Dawson's vision to recognize the emerging role of micro-LEDs in forging technological convergences between displays, lighting, communications and sensing systems, a vision he has promoted prominently to the international scientific and lighting communities.

3. The importance of micro-LED technology to new forms of scientific instrumentation, especially for applications in the life sciences and biomedtech. Of particular importance here has been their use in optogenetic probes in neuroscience and associated technology, which Dawson and his collaborators were first to demonstrate, in which they filed core IP subsequently purchased by Facebook, and which has grown into a substantial and broadly investigated underpinning technology (to which he and his colleagues continue to contribute) for the important optogenetic research field worldwide.

Dawson's specific pioneering contributions to micro-LEDs, implemented through an extensive series of collaborations, include:

- Scaling of passive matrix devices and in particular those based on pixels ~10μm in size, and their demonstration as monochrome micro-displays at blue and green wavelengths.
- Filing of a patent 'Micro-LEDs' (US7598149, 2003/04) defining and protecting the etching and metal conformation process underpinning the above demonstration. This patent subsequently (2009) assigned to spin-out company mLED Ltd and then assigned to Facebook as part of its acquisition of mLED (2016).
- Active matrix driving of a micro-LED array with dedicated CMOS driver electronics.
- Scalable flip-chip active and passive matrix displays.
- Operation of micro-LED devices with CMOS-based single photon counting/timing (SPAD) technology.
- Color conversion of micro-LED using colloidal semiconductor quantum dots.
- Ink-jetting of organic color converters for full-color micro-LED displays.
- Demonstrating ultra-high brightness micro-LED displays.
- Extending wavelength coverage of micro-LEDs to the near and deep ultraviolet.
- Deposition or etching of substrate-based microlenses pitch-matched to micro-LEDs.
- GaN/Si micro-LEDs and their transfer printing onto novel substrates (e.g. diamond) and electronics.
- Studying the fundamental physics of micro-LEDs in particular in relation to size and current density effects, including junction temperature, modulation bandwidth, color tuning, efficiency droop.
- A series of applications-driven visions of this technology in bioinstrumentation and the life sciences, including chip-scale microfluorimetry, optoelectronic tweezers, wide-field optical sectioning microscopy, and optogenetics/optogenetic optrodes for brain-computer interfacing. The latter underpinned by a patent subsequently purchased by Facebook (US10,694,953 B2).
- Demonstrating the high modulation bandwidth capabilities of micro-LEDs (~1GHz) for optical data comm applications (wireless and polymer optical fiber/waveguide) and identifying the underpinning mechanism as being current-density-dependent differential carrier lifetime.
- Showing the compatibility of the devices with high-level data encoding techniques for data communications, including pulse amplitude modulation and orthogonal frequency division multiplexing and wavelength division multiplexing and using these techniques to demonstrate multi-Gb/s (approaching 10Gb/s) data rates.
- Demonstrating a series of fast response color converters for wavelength diversity in micro-LED based optical wireless communications.
- 'Series-biased' devices for maintaining such data rates over ~10m distances.
- Multi-Gb/s deep ultraviolet micro-LEDs for solar-blind and non-line-of-sight communications applications.
- A range of spatial multiplexing techniques (e.g. multiple input, multiple output, MIMO) with micro-LEDs for Gb/s data communications.
- 'Indoor GPS' tracking and location capability with CMOS-interfaced micro-LEDs.
- Capability of micro-LEDs for inter-satellite communications with single-photon counting.
- Forming the spin-out company mLED Ltd (2010) and licensing patent US7598149 to that company, all subsequently acquired by Facebook/Oculus (2016), stimulating the worldwide commercial interest in these displays.

• Jury Comments

A nomination based, in part, on pioneering work with micro-LEDs (acknowledging early work with nomination prof. Hongxing Jiang). The nomination makes clear the applications attributable to the nominee (and his team and collaborators), going beyond display technology to optical data communications, LiFi compatible smart lighting technology, and scientific instrumentation (including medical). However, micro-LEDs are not the only aspect of this application, which also details much early fundamental work eg on gallium nitride. This is a nominee of enormous vision who is driving forward the potential of SSL across an impressive range of applications, and throughout a lifetime of highly productive academic work.

His very productive, rich career in academia and as scientific leader including exploitation of the original ideas by spin-offs resulted in wide ranging contributions to the development and application of III-V semiconductor devices, GaN micro-LEDs, and optically pumped lasers.

Outstanding achievements (and an outstanding application) .

He certainly made outstanding contributions in the field of semiconductor technologies.

Global SSL Award of Outstanding Achievement

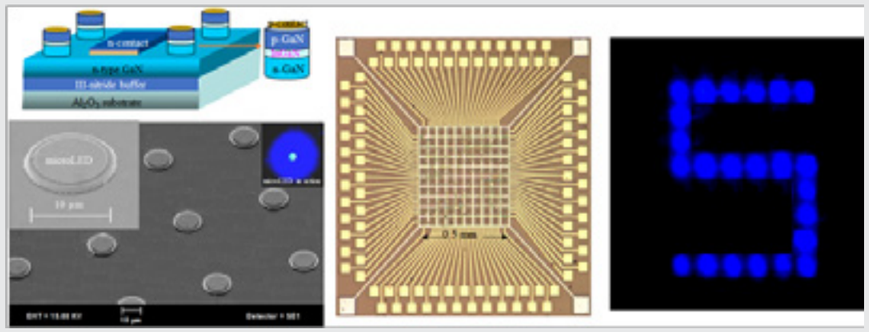
Professor Hongxing Jiang

Biography

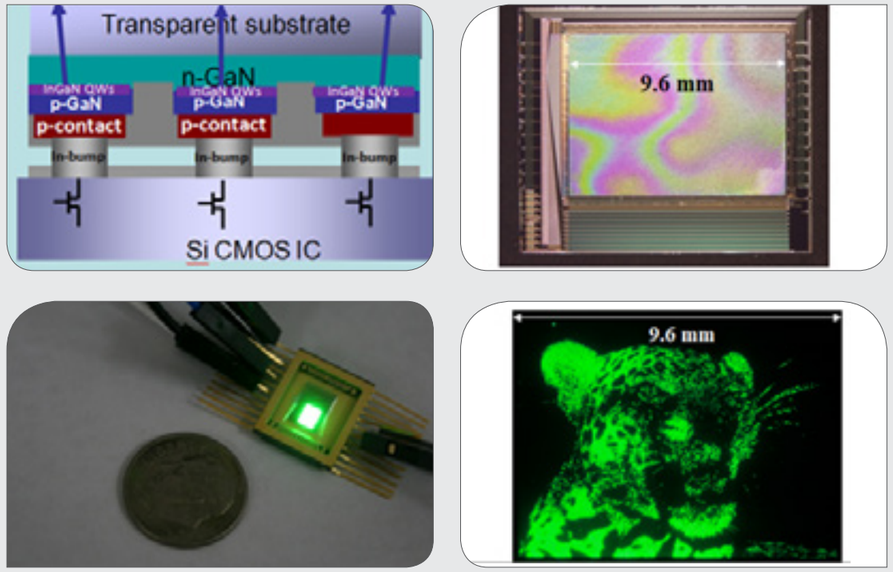
Professor Hongxing Jiang received his BS in Physics in 1981 from Fudan University, China. He came to US through the prestigious CUSPEA program created by Nobel laureate, Prof. Tsung-Dao Lee. He obtained PhD in Physics in 1986 from Syracuse University. Prof. Jiang has been working on III-nitride semiconductors since 1995. Currently, he directs the Nanophotonics Center and is the inaugural Edward Whitacre endowed chair and Horn Distinguished Professor of Electrical & Computer Engineering at Texas Tech University (TTU). In 2008, he relocated his research group to TTU from Kansas State University where he was a University Distinguished Professor of Physics. Prof. Hongxing Jiang is the original inventor of micro-LED, micro-LED microdisplay and high voltage DC/AC-LEDs. His invention of micro-LED forms the foundation for Micro-LED displays. Today, Micro-LED is considered as the ultimate display technology. The technology has also opened up promising developments for use as neural probes and neuron simulation applications in the field of medicine. More recently, his group has pioneered the development of epitaxial growth of boron nitride (BN) ultrawide bandgap semiconductor and BN thermal neutron detectors. He has been elected as a Fellow of the American Association for the Advancement of Science (AAAS), the American Physical Society (APS), the Optical Society of America (OSA), and the International Society for Optics and Photonics (SPIE) for his research impact in the field of wide bandgap semiconductor materials and devices. In 2018, he has also been elected as a Fellow of the National Academy of Inventors (NAI) for his original invention and development of micro-LED.

Outstanding Achievements Brief

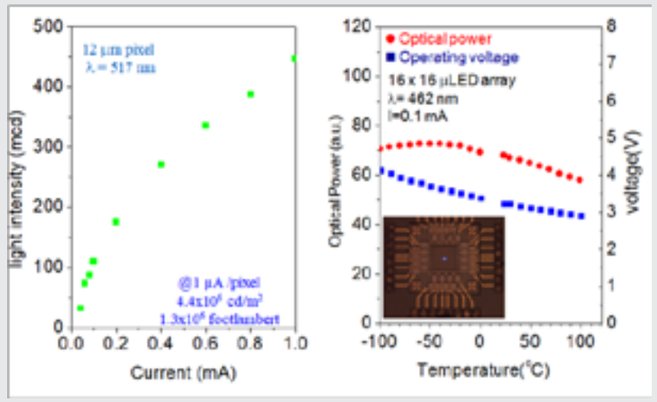
In 2000, Professor Jiang incepted the concept of Micro-LED. At the same year, his research team successfully demonstrated the operation of the first micro-LED and passive driving micro-LED microdisplay. These original works have already demonstrated the unique features of micro-LED and micro-LED microdisplays. In 2009, Prof. Jiang and his collaborators realized the first active driving high-resolution and video-capable micro-LED microdisplay in VGA format (640 x 480 pixels) via heterogeneous integration of micro-LED array with CMOS active-matrix driver. His team further demonstrated that Micro-LED microdisplays possess outstanding characteristics in comparison with other technologies such as LCD and OLED displays, including high brightness, efficiency, response speed, thermal stability, and contrast. Though the first active matrix driving Micro-LED microdisplay capable of video graphics images delivery realized by Prof. Jiang's team is monochromatic (blue or green), it demonstrated the validity of the Micro-LED technology and transitioned Micro-LED from prototype concept to reality. Today, Micro-LED is poised to become the technology of choice for 3D, augmented reality (AR), virtual reality (VR) and large flat panel displays, and light source for visible light communications (Li-Fi). His invention of high-voltage DC and AC-LEDs eliminated the need of transformers for LED lighting and has been broadly commercialized for general lighting and automobile headlights to increase their durability while reducing costs. More recently, his group has pioneered the development of epitaxial growth of wafer scale hexagonal boron nitride (BN) ultrawide bandgap semiconductor and realized BN thermal neutron detectors with a record high efficiency to date among solid-state neutron detectors. Micro-LED is also expected to make a large impact in the field of medicine for neural stimulation and optogenetics, to aid people who are blind or have sight loss; and for optical cochlear implants to aid people with hearing loss.



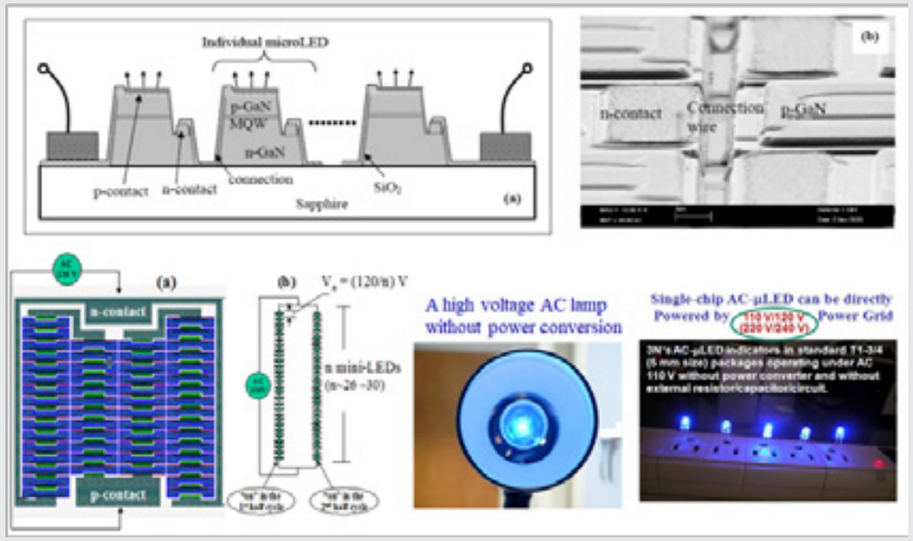
The first micro-LED and passive driving micro-LED microdisplay invented in 2000 by Prof. Hongxing Jiang's research team [US patent 6,410,940; Appl. Phys. Lett. 76, 631 (2000); Appl. Phys. Lett. 78, 1303 (2001)].



In 2009, Prof. Jiang and his collaborators realized the first active driving high-resolution and video-capable micro-LED microdisplay in VGA format (640 x 480 pixels) via heterogeneous integration of micro-LED array with CMOS active-matrix driver [US patent 9,047,818 (Priority date: 03/23/2009); Appl. Phys. Lett. 99, 031116 (2011); SPIE Newsroom, Dec. issue (2011) doi: 10.1117/2.1201112.004001].

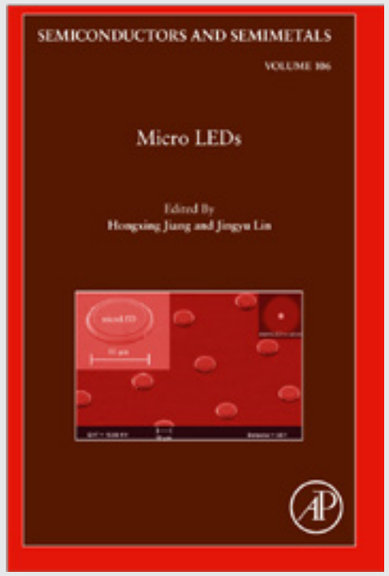


Professor Hongxing Jiang's research team demonstrated that Micro-LED microdisplays possess outstanding characteristics in comparison with other technologies such as LCD and OLED displays, including high brightness, efficiency, response speed, thermal stability, and contrast [US patent 9,047,818 (Priority date: 03/23/2009); Appl. Phys. Lett. 99, 031116 (2011); SPIE Newsroom, Dec. issue (2011) doi: 10.1117/2.1201112.004001].



Professor Jiang's invention of high voltage DC and AC-LEDs eliminated the need of transformers for LED lighting and has been broadly commercialized for general lighting and automobile headlights [US patents 6,957,899; 7,221,044; 7,535,028; 8,272,757; 7,714,348 and Chinese patent 1819255].

Comparison among various technologies for Microdisplays Appl. Phys. Lett. **99**, 031116 (2011)					
Technology	**Liquid crystal**	**Organic LED**	**III-nitride Micro-LED**	**Digital light processing**	**Laser beam steering**
Mechanism	Backlighting/LED	Self-emissive	Self-emissive	Backlighting (LED)	Backlighting (Laser diode)
Luminous efficacy	Medium	Low	High	High	High
Luminance	< 200 cd/m^2 (Full color) < 2000 cd/m^2 (Green color)	1500 cd/m^2 (full color)	~ 10^5 cd/m^2 (Full color) ~ 10^7 cd/m^2 (Blue/Green)	~ 1000 cd/m^2 (Full color)	~ 1000 cd/m^2 (Full color)
Contrast ratio	100: 1 (intrinsic)	Very high >10,000:1	Very high >10,000:1	High	High
Response time	ms	ms	ns	ms	ms
Operating temperature	0 to 60 °C	-50 to 70 °C	-100 to 120 °C	To be determined	NA
Shock Resistance	Low	Medium	High	Medium	Medium
Lifetime	Medium	Medium	Long	Medium [limited by MEMS]	Short [limited by LDs]
Cost	Low	High	High	High	High



• Jury Comments

A science and technology based nomination for invention of the micro-LED. The importance of micro-LEDs is made clear and many applications described. He has certainly been active in advancing various aspects of display systems, and commercialization of the technology.

His patented original technological innovation of micro-LEDs resulted finally in the realization of self-emissive micro-LED and large heterogeneously integrated flat panel displays being technically superior to competitor LCD and OLED panels. His S&T contribution has enormous commercial impact.

Outstanding achievements (and an outstanding application).

His outstanding contributions are in the area of micro-LEDs and display technologies.

Global SSL Award of Outstanding Achievement

Jury Panel 2021

Ann Webb

Professor, University of Manchester

Former President of CIE

Guoqi Zhang

Professor of Delft University of Technology

Co-Chair of ISA Board of Advisors

Istvan Barsony

Former Director of Research Institute for Technical Physics and Materials Science – MFA, Hungarian Academy of Sciences

Professor of Centre for Energy Research Hungarian Academy of Sciences, University of Pannonia, Hungary

Member of ISA Board of Advisors

Ling Wu

President, China SSL Alliance (CSA)

Member of ISA Council of Management

Shuji Nakamura

Laureate of 2014 Nobel Prize in Physics
Research Director of the Solid State Lighting & Energy Center

Professor of Materials, University of California, Santa Barbara

Co-Chair of ISA Board of Advisors

Warren Julian

Past President of IIluminating Engineering Society of Australia and New Zealand (IESANZ)

Emeritus Professor, University of Sydney

Member of ISA Council of Management

Yoshi Ohno

Doctor, NIST Fellow, National Institute of Standards and Technology, USA

Past president of CIE

Member of ISA Board of Advisors

Chairman of ISA TCS

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