MicroLED Association

White paper:

MicroLED Microdisplays Soft-Standard

(Edition 1.0, November 2024)

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By the MicroLED Industry Association

MicroLED Association

This document, by the MicroLED Industry Association, aims to provide guidelines for microLED microdisplay developers and device makers, in an emerging and nascent market environment.

This is the first edition of this document, released in November 2024. The MicroLED Association plans to release a second edition by the end of March 2025, adding information on system-level considerations such as eye-comfort, heat dissipation and color alignment.

A Short Intro to MicroLED Microdisplays

One of the first potential markets for microLEDs is microdisplays, as microLED enables superior performance compared to other technologies:

* High brightness
* High efficiency
* Small form factor
* High pixel density
* Long lifetime

A microLED microdisplay is defined by its small display size (usually up to 2-inch diameter) and high pixel density. Most such microdisplays use a high-performance silicon (CMOS) backplane and are suitable for near-eye applications, such as AR/VR headsets, rifle sights, camera viewfinders, etc.

For more information on the production process of microLED microdisplays, consult our Monolithic MicroLED Integration white paper and the MicroLED Association roadmap here: https://www.microledassociation.com/downloads.

MicroLED Microdisplays Properties

Microdisplays

We assume that all MicroLED microdisplays are rectangular in shape. Accurately detailing the display size will involve three factors:

1. Active-area size, defined in mm x mm of the actual emissive area (without any spare pixels if these exist).
2. Panel area, defined in mm x mm of the total module size, including bezels.
3. Diagonal size, defined in inches from top-left to bottom-right. This item by itself is not enough to correctly detail the display size, but it is the one most commonly used to quickly identify a display.

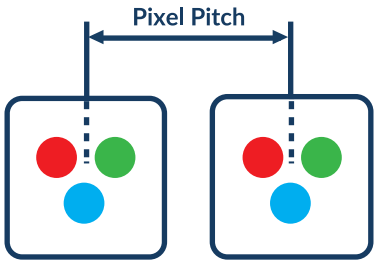
Resolution and pixel density

The resolution and density of a display are both important factors. These are usually defined by a Pixel-Per-Inch (PPI) specification, and a pixel-pitch.

In some markets, it is common to quote the number of 'dots' to denote the resolution (for example in camera viewfinder displays). This is a confusing term and we do not encourage it, but rather propose to always state the complete resolution: the number of horizontal pixels and vertical pixels (i.e., 1920 x 1080).

The PPI specification can be ambiguous, as the vertical PPI can be different than the horizontal PPI, but in most displays the distance between the pixels will be the same horizontally and vertically, and thus a single PPI number is enough to correctly describe the display's density.

The pixel pitch is defined as the distance between the centers of adjacent pixels. Again, we assume the horizontal pixel pitch will almost always be identical to the vertical pitch.



Display speed: refresh rate, and response time

The display speed is another very important metric, especially for near-eye VR and AR devices, where fast animations and head movements can easily create motion sickness.

Every display has two important, and different, metrics when it comes to speed:

* Refresh rate – the number of frames the image changes in a second, measured in Hertz. This metric is sometimes referred to as Motion Picture Response Time (MPRT).
* Response time - measures how fast a pixel can change its state, moving from one color to the other

The refresh rate of the display is quite standard and has to comply with video refresh rates.
The response time of the display is more complicated and can be ambiguous. Some makers will report the time it takes for a pixel to change from white to black and then back to white, or sometimes from a specific gray level to another gray level and back again (G2G). We recommend that all microdisplay makers publish the refresh rate in addition to a G2G response time.

Light output (brightness)

A display light output, or brightness, is measured in cd/m2 (also called nits). The basic unit measures the number of candelas (equivalent to the light output of a single wax candle, hence the name), projected onto an area that is 1 sqm in size. cd/m2 is a standard measurement term, used by display makers all over the world, and it needs to be measured in a screen that is completely white. This is cited as the display's brightness level.

With microLEDs (this is also true for OLED displays), there is an important issue related to the picture shown on the display. The Average Picture Level (APL) measures the percentage of lit pixels from the total number of pixels in the display. An APL of 100% is a completely white image, while an APL of 50% means that only half of the pixels are lit, with the other half completely black. If the screen is completely white (100% APL), for example, the maximum brightness level of each pixel may be lower than if there are only a few lit pixels in the display (APL < 100%) as the display maker usually has to limit the total power consumption of the display (this is called Auto Brightness Limiter, or ABL). In a completely white image, each pixel will draw less power than in an image where only a handful of pixels are lit.

This means that microLED display makers should refer to two different metrics:

1. Normal brightness (measured in cd/m2 by a completely white screen, 100% APL)
2. Peak brightness – measured in cd/m2 while also specifying the APL (we recommend 25% to be used in standard measurements).

Color accuracy, color gamut

The color gamut (total 'number' of colors the display can show) and the accuracy of the image reproduction are two important metrics. While it is likely that the first displays and solutions will focus on efficiency and brightness, it is also likely that as the industry progresses, the importance of color reproduction will increase.

Specifying the display's color gamut is usually done by stating the percentage of colors achieved from a specific gamut, such as "93% of DCI-P3". Commonly used standards include sRGB(Rec.709), BT.2020 and DCI-P3. We recommend that displays should accurately support both the sRGB and DCI-P3 color gamuts. BT.2020 is a newer color gamut, with very little content as of the current state, but could be important in the long term.

Note that some displays offer 'vivid modes', with an extended color gamut (for example 110% DCI-P3). This is preferred by some users. In addition, such a mode enable a compensation for a reduced gamut (washed out colors) in ambient light conditions.

Note, also, that AR is still at an early stage, and market-side performance requirements are not yet known. It is likely that the required (or recommended) color gamut will vary with the actual AR application and use case.

Display lifetime

While LED emitters feature very long lifetimes, it is still important to note that the lifetime of LEDs is limited, and in addition, as each LED is driven independently (depending on the image shown), different aging may take effect and lead to burn-in.

Lifetime is quoted as the number of hours by which the brightness reaches a percentage of the original brightness. For example, LT50 means the number of hours until the brightness drops by 50%.

It is important to note that as the LEDs age, they may also shift the emission spectrum, which means that their color would change.

There are several factors that make this measurement complicated at the system level:

* Each color subpixel microLED (red, green and blue) may degrade differently (depending on the LEDs used, and the display's architecture).
* Display makers may choose to implement compensation technologies and algorithms – both at the display panel level (hardware compensation), and at the system level (software compensation). Hardware compensation is part of the microdisplay device – but its effect on lifetime depends on the usage pattern, and may have other effects on the display (for example reduce total brightness, or increase power consumption).

As this complicates the actual lifetime measurement, we suggest that display makers adhere to a strict measurement:

1. LT90 of a white pixel with less than 5% change in CCX and CCY, following a completely white image
2. LT50 of a white pixel with less than 10% change in CCX and CCY, following a completely white image
3. Disclose any hardware compensation technologies being used, if possible

Temperature range

For many AR applications, such as military and industrial use cases, it is very important to operate in a wide temperature range. The storage temperature range for displays is also important.

Display makers should specify both temperature ranges:

1. Operating temperature range, from low to high, in Celsius
2. Storage temperature range, from low to high, in Celsius

We recommend that display maker specifically note if towards the high end of the temperature range, the display remains operative but may be effected in terms of image quality, color range or lifetime.

Luminous efficiency

The efficiency of a display is a highly important aspect, and in mobile AR headsets, the power consumption and heat generation are critical issues. MicroLED displays promise higher energy efficiency compared to competing technologies, so this metric is vital for market adoption.

The common measurement unit for luminous efficacy is lumens per Watt, or lm/w.

As microLEDs are self-emissive, there are several factors that affect the efficiency:

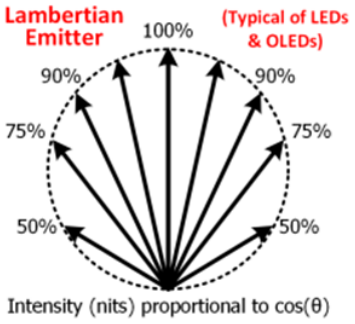
- The image shown on the display
- The temperature
- The brightness

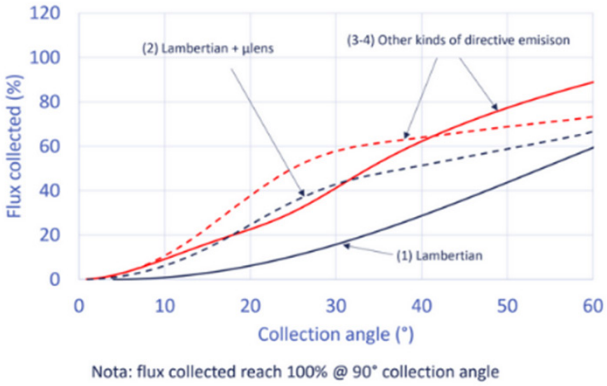
We recommend that all lm/W specifications will be presented under two conditions:

1. A 100% white image shown on the display (a 5000K color point), 2,000 nits of brightness, 25 degrees Celsius.
2. A 50% white image (the rest black pixels) shown on the display (a 5000K color point), 2,000 nits of brightness, 25 degrees Celsius.

Light Collimation

For microdisplays, it is vital to understand the light collimation – whether the light is emitted in a narrow angular range, or a wide one. The Lambertian nature of microLEDs may be problematic in some microdisplay applications and reduce the efficiency and perhaps the image quality as well. We assume that most systems will use waveguides, and thus point the standard recommendation towards such systems.





Nota: flux collected reach 100% @ 90° collection angle

The image on the left shows the flux collected by a waveguide, depending on the waveguide collection angle and the light source (source: Aledia)

Current waveguides apertures range from 20° to 30°, so a Lambertian source will inject into the waveguide (assuming a 25° half aperture waveguide) less than 10% of total emitted flux.

Note that adding a microlens layer improves and directs the light output of the microLEDs, it is estimated that standard microlens arrays will increase the light injection into the 25° waveguide to over 30% (up from <10%).

We recommend that display makers will disclose the flux light output at full space, and also at a 25°. These two metrics will help understand the actual usable light output of the device.

Member Directory

#Lasers, #production equipment, #Mass transfer, #inspection & repair

3D-Micromac

Laser equipment for µLED forward transfer, lift-off and repair process steps - ready for high volume production

Germany-based 3D-Micromac AG is the industry leader in laser micromachining and roll-to-roll laser systems. The company develops and manufactures processes and laser systems delivering powerful, user-friendly and leading-edge processes with superior production efficiency.

3D-Micromac systems and services have been successfully implemented in various high-tech industries worldwide. This includes semiconductor, photovoltaic, glass and display industry, electronics, as well as medical device technology.

For microLED display manufacturing, 3D-Micromac offers industrial laser solutions for mass production:

- Laser-Induced Forward Transfer (LIFT) which enables the transfer of hundreds of millions of microLEDs without having to apply mechanical forces
- Laser Lift-Off (LLO) which guarantees a highly uniform, force-free lift-off of different layers on wafer and panel substrates
- REPAIR: Single die repair process at every step of the microLED production process

https://3d-micromac.com/

#materials & technologies

3M

Produces a wide range of products including electrical and electronic connecting and insulating materials, and optical films.

The 3M Company, based in the US, operates in the fields of industry, worker safety, U.S. health care, and consumer goods. The company produces a wide range of products (over 60,000, in fact) including adhesives, abrasives, laminates, passive fire protection, protection films, dental and orthodontic products, electrical and electronic connecting and insulating materials, and optical films.

3M's Display Materials and solutions Division (DMSD) is offering several products for the industry – transparent adhesives (OCAs), micro/nanoreplication technologies, printable optical materials, and multilayered optical films.

https://www.3m.com

#microdisplays, #LED epiwafers

ALEDIA

Aledia is a start-up company established in 2021 in the Grenoble area (France) to develop GaN nanostructure-based LEDs for Display applications. It has 220 people (30% PhDs), has more than 250 patent families granted or in application, and has raised €270M in four financing rounds.

Aledia has two nanowire LED platforms, one based on blue GaN nanowires on 8-inch wafers, and the second that utilizes RGB LEDs. The company targets a wide range of markets, from AR microdisplays to TVs and videowalls.

Aledia has built a factory near Grenoble (France) for high volume epitaxial growth and low volume LED processing manufacturing; high-volume manufacturing capacity is being implemented in different countries including in Asia, closer to the market.

https://www.aledia.com/

#materials & technologies, #LED epiwafers

ALLOS Semiconductors

GaN on Silicon IP licensing and technology

ALLOS Semiconductors is an IP licensing and technology company that focuses on GaN-on-Si technology.

For the micro-LED market, ALLOS offers a turn-key technology transfer to establish a super-uniform CMOS-compatible large (200 mm) epiwafer process at customers within only 12 weeks.

https://www.allos-semiconductors.com

#LED epiwafers

ams-OSRAM

In an increasingly connected world, sensing is taking a crucial role by closing the gap between the physical and the digital. Using the full spectrum of light we allow humans and machines to capture and understand the world around us. Combining sensors, software and emitters, we bring the information that our environment holds to light by capturing, analyzing and visualizing it. We sense the world and make sense of it.

https://ams-osram.com

#production equipment | mass transfer #inspection & repair

Applied Materials

Applied Materials is a world leader in materials engineering solutions used to produce semiconductors and advanced displays. The company offers a wide range of equipment for the production and testing of displays.

For the microLED industry, Applied Materials develops a complete mass transfer, inspection and repair process. The company also offers its own display architecture based on UV LEDs and QD color conversion.

https://www.appliedmaterials.com/

#MicroLED research

CEA Leti

One of the world's largest microelectronics and nanotechnology organizations

CEA-Leti is a non-profit research institute based in Grenoble, France. CEA-Leti is one of the world's largest microelectronics and nanotechnology organizations.

Leti is developing micro LED displays, with a focus on high-performance microdisplays. Leti has implemented this LED technology to manufacture high-brightness uLED arrays hybridized on silicon circuit with a 10-um pixel pitch and the institute manufactures blue and green arrays offering a brightness of 107 cd/m².

http://www.cea.fr/english

#Lasers, #production equipment, #mass transfer

Coherent

Laser-based solutions for the microLED industry: from a single laser source up to LLO, LIFT and repair systems

Coherent makes the amazing possible using the power of light. Performance, quality, and a global expert network support our customers in scientific, medical, electronics, and manufacturing markets.

MicroLEDs represents an exciting opportunity, potentially lowering the costs for very large area displays as well as some small area display applications. High energy, ultraviolet lasers are the key to success to cut production costs, increase throughput, and improve quality. Coherent provides several solutions from a single laser source, optical systems up to an integrated system for the three vital processes in MicroLED fabrication: Laser Lift-Off (LLO), Laser-Induced Forward Transfer (LIFT), and Repair/Trimming. Coherent also covers more process steps of the entire MicroLED production chain from laser cutting by ultrashort pulse lasers to Laser Assisted Bonding (LAB) by diode lasers.

http://www.coherent.com/

#materials & technologies, #LED epiwafers

Comptek Solutions

Develops quantum technology that boosts the performance of devices such as microLEDs and lasers

Founded in 2017 as a spin-off from the university of Turku, Finland, Comptek Solutions develops quantum technology (branded as Kontrox) that boosts the performance of devices such as microLEDs and lasers and makes their manufacturing process easier by solving the problem of aggressive oxidation of compound semiconductor materials.

Kontrox results in a high-quality passivation layer with substantially reduced defect densities that help to greatly decrease the surface recombination phenomena which is a predominant mechanism for such small devices.

Comptek says that MicroLED efficiencies increase significantly with Kontrox, the company has demonstrated up to 250% EQE (external quantum efficiency) improvements.

http://www.comptek-solutions.com

#materials & technologies

Corning

Corning develops and produces specialty glass, ceramics, and related materials and technologies including advanced optics, primarily for industrial and scientific applications. For the display industry, Corning supplies both rigid and flexible glass substrates, glass carriers and cover glass.

Together with its customers, Corning evaluates opportunities in the microLED industry, where a glass solution aligns with its deep materials science expertise.

https://www.corning.com/

#materials & technologies

DELO

DELO is a leading manufacturer of high-tech adhesives and other multifunctional materials as well as corresponding dispensing and curing equipment. Their products are mainly used in the automotive, consumer electronics and semiconductor industries. They can be found in almost every mobile phone and half the cars worldwide, for example in cameras, loudspeakers, electric motors, or sensors. Customers include Bosch, Daimler, Huawei, Osram, Siemens, and Sony. The company has 1,000 employees and achieved revenues of €204 million in fiscal 2023.

Additionally, adhesives facilitate miniaturization, increase performance, and improve device functionality and reliability, from tiniest SMD component like miniLED and microLED to large size edge sealing.

https://www.delo-adhesives.com

#mass transfer

eLux

Massively parallel fluidic assembly of microLED displays

eLux Inc. was established in 2016 in the USA as a spin-out from Sharp Labs of America. eLux expertise and intellectual property development focus on the massively parallel assembly processes that enable low cost manufacturing of microLED displays.

https://www.eluxdisplay.com/

#materials & technologies, #microdisplays, #MicroLED Research

Fraunhofer FEP

Electron beam technologies, vacuum thin film deposition techniques and technologies for organic electronics, microdisplay technology and sensorics.

The Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP is one out of 76 institutes and research units of the Fraunhofer-Gesellschaft e. V., the largest European institution for applied research. The core competences of Fraunhofer FEP are electron beam technologies, vacuum thin film deposition techniques and technologies for organic electronics, microdisplay technology and sensorics. Main activities target development and adaption of the thin film deposition technologies to a wide range of industrial applications. Fraunhofer FEP runs multiple pilot scale vacuum coating systems.

Furthermore, Fraunhofer FEP has a unique position in designing microelectronic circuits and components with application- and customer-specific adaptations of silicon circuit foundries' CMOS processes that allow these finished wafers to be subsequently processed with OLED coatings, for example. This subsequent processing is used in particular for augmenting silicon CMOS wafer functionality with optical and photonic components, such as for high-resolution OLED microdisplays.

https://www.fep.fraunhofer.de/en.html

#materials & technologies, #MicroLED Research

Fraunhofer IZM

One of the world's leading institutes for applied research and the development and system integration of robust and reliable electronics

For 30 years, more than 440 employees have been finding technological solutions in cooperation with partners from industry and academia. Emerging challenges are addressed in branches such as automotive and industrial electronics, medical engineering, ICT and semiconductor technology.

Our technologies connect the individual components, protect components and devices from vibration and moisture, and reliably dissipate heat. Fraunhofer IZM thus ensures that electronic devices continue to function reliably in even the harshest conditions. Modern packaging technologies make developing smaller and smaller products possible. We process ICs thinner than a sheet of paper. The institute, founded in 1993, disposes of a lab area of over 8,000 sqm. About 80 percent of our turnover in 2021 was earned through contract research.

https://www.izm.fraunhofer.de/en.html

#color conversion

General Electric

For more than 125 years, GE has invented the future of industry. Today, GE is best known for its work in the Power, Renewable Energy, Aviation and Healthcare industries.

GE's Licensing team provides access to GE's patent portfolio and technical and intellectual resources. Licensees receive world-leading technology paired with advice and guidance to accelerate their technology development and achieve market differentiation.

The GE LED Phosphors team has world class chemistry and physics expertise as well characterization capabilities that have resulted in commercial successes in both lighting and LCD display technologies. Multimillion-dollar yearly revenue, multiple awards, hundreds of patents, over 20 licensees of our patents, along with various publications and invited conference presentations show that this team is on the cutting edge of luminescent material development and can advance from concept to invention to commercialization.

https://www.ge.com

#inspection & repair

InZiv

Testing and inspection tools for the microLED industry.

InZiv provides testing and inspection tools for the microLED industry. InZiv's technology offers one comprehensive platform for both full wafer mapping and individual chip testing and characterization at the highest resolution. Automated PL and EL provide today's most critical measurements, including EQE and angular measurements, and Nano-PL and Nano-EL enable the user to zoom in on individual chips and sub-pixel features and defects with 100nm resolution.

InZiv integrates multiple inspection modalities in one system, and provides a comprehensive analysis of both the whole wafer and its sub-pixel features. This unique combination empowers microLED developers and manufacturers with the ability to better understand the relationship between light, color, current, and structure – directly addressing today's most critical challenges in microLED.

https://inziv.com/

#inspection & repair

Instrument Systems

Develops and produces high-end light measurement technology, (AR/VR) displays, mLED wafers, VCSEL/laser systems, automotive lighting and LED/SSL modules.

Instrument Systems GmbH, founded in Munich in 1986, develops and produces high-end light measurement technology that is indispensable for the manufacturers of consumer electronics, (AR/VR) displays, mLED wafers, VCSEL/ laser systems, automotive lighting and LED/SSL modules. All solutions benefit from our CAS series of high-precision spectroradiometers that are recognized and in use all over the world. In combination with 2D imaging colorimeters, integrating spheres and goniometer systems, they enable high-precision and accurate measurements in the entire range from UV to IR, traceable to PTB or NIST.

Today, Instrument Systems is one of the world's leading manufacturers of light measurement technology. At its Berlin facility, the "Optronik Line" of products is developed and marketed for the automotive industry and traffic technology. Our subsidiary in Korea supplements the product portfolio with the "Kimsoptec Line" for the Korean light & display market.

Instrument Systems has been a wholly-owned subsidiary of the Konica MinoIta Group since 2012.

https://www.instrumentsystems.com/en/

#microLED displays

LG Electronics

The LG Business Solutions Company is a trusted partner offering innovative products and solutions for diverse industries worldwide.

With a portfolio of unique offerings, such as industry-leading OLED signage, LED signage and commercial TVs, LG is a respected name among customers around the world.
For more on LG's Business Solutions, visit www.LG.com/b2b

https://www.lg.com/global/business

#color conversion

Mitsui Kinzoku

Produces functional engineered materials and electronic materials, nonferrous metal smelting.

Japan-based Mitsui Mining & Smelting (also known as Mitsui Kinzoku) produces functional engineered materials and electronic materials, nonferrous metal smelting, minerals resource development, precious metal recycling, raw material related businesses, manufacturing and sale of automotive parts/components, etc.

For the MicroLED Industry, Mitsui Kinzoku developed a sulfide phosphor for color conversion. The material is highly durable and does not contain any hazardous material. As of 2023, the company is sampling the material for microLED developers.

https://www.mitsui-kinzoku.co.jp/mlab/en/

#Materials & Technologies

Mojo Vision

Developing RGB Micro-LED displays

The Future of Micro-LED Technology is Here

Mojo Vision is focused on developing and commercializing world-class micro-LED technology for consumer, enterprise, and government applications. Developed as a critical component of Mojo Lens and first announced in 2019, the Mojo Vision Micro-LED Display is the smallest, densest dynamic display ever made, and the Micro-LED technology platform underlying it is powerful and flexible enough to serve a wide range of applications from next generation wearables all the way up to future televisions and video walls. We believe Micro-LED will disrupt the entire $160B display industry and our unique technology puts us at the forefront of this disruption.

https://www.mojo.vision/

#display drivers

nsc innovation

Monolithically integrating GaN LEDs with silicon CMOS to enable microdisplay solutions

nsc is a groundbreaking integrated circuit design company based out of Singapore. Our chips are the first to effectively integrate silicon CMOS with GaN LEDs monolithically and at full wafer scale, while maintaining compatibility with traditional CMOS manufacturing. By doing so, nsc offers the functionality and manufacturability needed to enable widespread adoption of microdisplays. These highly efficient and cost-effective LED pixelated light engine (PLE™) chips can serve as the backbone for displays that will change the form factor of wearables, increase battery life, decrease cost, and make possible game-changing new product innovations. Our integrated chips are produced by co-opting existing manufacturing equipment and processes in order to deliver them at commercial scale.

https://www.nscinnovation.com

#Color conversion

QNA Technology

Quantum dots for the display industry, based on unique surface engineering and QD inks

Poland-based QNA Technology, established in 2016, develops and produces quantum dots for the display industry.
The company optimizes its QDs for two applications: electroluminescence display devices (QD-EL) and for microLED displays devices based on UV microLEDs.

QNA developed QD surface engineering to enable the delivery of its materials in various solvents, such as polar, non-polar, monomers, powders, and more. The company is also developing QD inks for ink-jet printing and for UV-curable inks.

https://qnatechnology.com/en/

#Color conversion

Qustomdot

Cadmium-free quantum dots technology for microLED displays

Belgium-based QustomDot brings unmatched colors through quantum dot (QD) color conversion to microLED applications. The team combines QD synthesis, surface engineering and ink/photoresist formulation into patterned color conversion layers for microLED displays. QustomDot's patented technology is cadmium free and can withstand high light intensities.

https://www.qustomdot.com

#Materials & Technologies

Radiant Vision Systems

Automated inspection systems for microLED displays

US-based based Radiant Vision Systems, a Konica Minolta company, provides advanced imaging systems to critically evaluate light, color, manufacturing integrity, and surface quality of illuminated displays and device assemblies.

Radiant offers fully customized and automated inspection systems for microLED development and production.

https://www.radiantvisionsystems.com

#Materials & Technologies

Smartkem

Seeking to reshape the world of electronics with a revolutionary semiconductor platform that enables the next generation of low-cost displays and sensors.

SmartKem's patented TRUFLEX® inks are solution deposited at a low temperature, on low-cost substrates to make organic thin-film transistor (OTFT) circuits. The company's semiconductor platform can be used in a number of applications including mini- and micro-LED displays, AMOLED displays, AR and VR headsets, fingerprint sensors and integrated logic circuits. SmartKem develops its materials at its research and development facility in Manchester, UK, and its semiconductor manufacturing processes at the Centre for Process Innovation (CPI) at Sedgefield, UK. The company has an extensive IP portfolio including over 124 issued patents across 19 patent families.

https://www.smartkem.com

#MicroLED research, #LED epiwafers

Solid State Lighting & Energy Electronics Center

Researchers to advance solid-state lighting and energy efficient power switching using wide-bandgap semiconductors.

The Solid State Lighting & Energy Electronics Center (SSLEEC) at UC Santa Barbara is a collaborative center, which partners key industry leaders and UCSB researchers to advance solid-state lighting and energy efficient power switching using wide-bandgap semiconductors.

SSLEEC is focused on new semiconductor based technologies for disinfection, advanced mobile displays, energy efficient lighting, and power electronics. The objective of the SSLEEC is to provide a forum for its members – key industry partners and the faculty and student researchers at the University of California, Santa Barbara – to work in collaboration and across scientific disciplines to address the most challenging problems in these important and timely areas of research.

https://ssleec.ucsb.edu

#microLED displays

STRATACACHE

Digital signage systems developer, microLED display producer

STRATACACHE is a digital signage, merchandising and customer engagement systems developer, targeting the retail, restaurants, banking and financing, gaming, events and education markets.

STRATACACHE is constructing the first US-based complete display production facility in Eugene, Oregon, the future MicroLED E4 fab.

https://www.stratacache.com/en/

#production equipment

Tokyo Electron (TEL)

Global semiconductors production equipment maker

Tokyo Electron Limited (TEL) is a Japanese electronics and semiconductor company headquartered Tokyo, established in 1963. TEL supplies equipment to fabricate ICs, photovoltaic cells and flat panel displays. TEL is considered to be the world's largest manufacturer of IC and FPD production equipment.

https://www.tel.com

#Mass transfer, #materials & technologies

Terecircuits corporation

Photo-polymer mass transfer system for microLED production

Terecircuits develops technologies and manufacturing processes for microassembly based on a new class of photo-chemical polymers.

The company focuses on the development of a microLED photo-chemical mass transfer process.

http://terecircuits.com/

#microLED displays, #mass transfer, #microdisplays

Vuereal

Micro-LED display technologies and display production

Canada-based VueReal is a startup company that develops Micro-LED display technologies. VueReal developed a cartridge-based microLED printing process that can produce high density displays at high production yields.

In addition to microLED technologies, VueReal also produces microLED displays, and offers custom display production done at its pilot production line in Waterloo, Canada.

https://www.vuereal.com

#inspection & repair

WEVE

Infinite Possibilities

World-class inspection of Epi Wafers, Micro LED CoWs, and OLED

WEVE is a South Korea-based company with industry-leading expertise in Epi wafer and CoW inspections. We are trusted by world-leading display and wafer manufacturers in South Korea and Taiwan. Our contactless and nondestructive technology performs AOI, PL, and Color Difference (xyY, WD) analysis in a single run. Conducting such a complex analysis is meaningless if inspection time greatly exceeds the realities of mass production. We provide crucial data set under acceptable time 6-inch CoW – under 10 minutes, 6-inch Epi Wafer – under 12 minutes. Being involved in big-scale productions we have accumulated great experience that helps our technology to be extremely useful in real environments. WEVE is among the very few in the world in terms of the total number of wafers inspected. We are always open to partnerships and new business development.

https://en.theweve.com

#MicroLED Microdisplays

XPANCEO

XPANCEO is a deep tech company developing the next generation of computing via an invisible and weightless smart contact lens

The XPANCEO smart lens reinvents the whole concept of human-technology interaction and redefines the way we experience both real and digital worlds, including social media, content consumption, and gaming.

https://www.xpanceo.com/