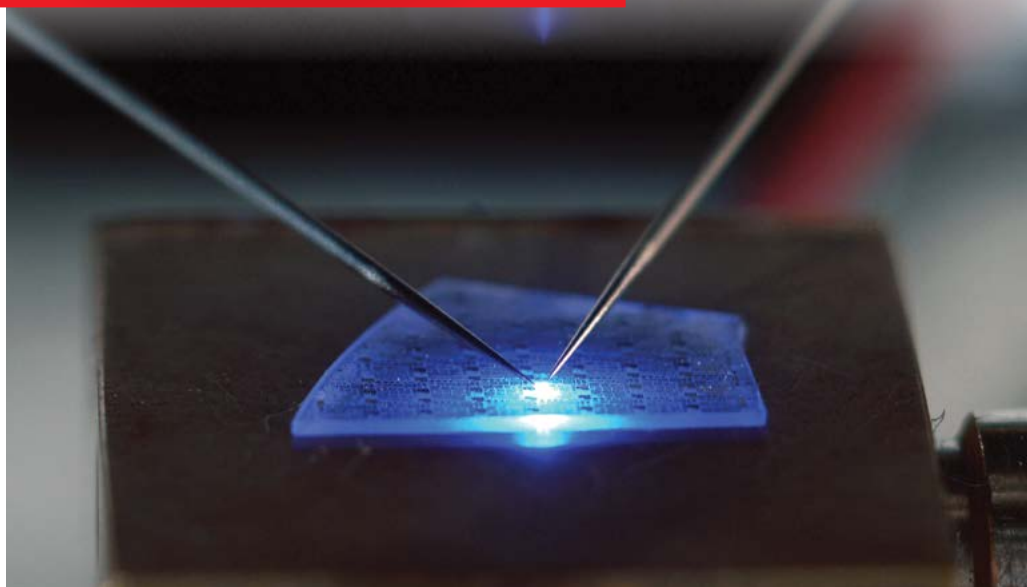


leti
cea tech

MICRO-LED ARRAYS

Tomorrow's smart lighting
and display technology



Leti, technology
research institute

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MicroLEDs: next generation smart lighting and display components

The next generation of smart lighting products will better control lighting intensity, shape, direction and color by integrating pixelated light sources, while display applications will be more energy efficient. GaN microLED technology fulfills both these projections by combining the efficiency of GaN LED direct emission and potential for manufacturing few micron size LEDs.

SMART LIGHTING

Automotive lighting, outdoor lighting, indoor lighting, etc.

- Better use of time, space & intensity
- Non-visual effects
- Health and wellness
- More than light: visible light communication
- Better light usage by spatial, intensity, data and color control



DISPLAY

Projection, flexible, transparent, head-up & head-mounted displays

- More pixels
- Energy saving
- Brighter
- Better image quality: contrast, color saturation (true red, true green, true blue), view angle
- Robust
- More functionalities: transparent screens, foldable screens, autonomous energy harvesting

Key requirements:

MORE BRIGHTNESS & SMALLEST PITCH

MicroLED arrays meet both

through high performance, low consumption, compact products combining brightness and small pitch.

LETI'S COMPLETE MICRO-LED ARRAY PROCESS

LETI'S VALUE PROPOSITION EMBRACES A COMPLETE DESIGN TO SYSTEM CHAIN

CHALLENGES

GaN pixelization

- Auto aligned process for optimizing process flow
- Pitch reduction: down to ~1 μm
- Planar interfaces for optimizing hybridization

Hybridization

- Wide hybridization portfolio
- Cold process: micro-tubes for hybridization down to 10 μm pitch
- Direct heterogeneous bonding for smaller pitch down to 1 μm
- Metal/metal or oxide/oxide direct bonding

Color conversion

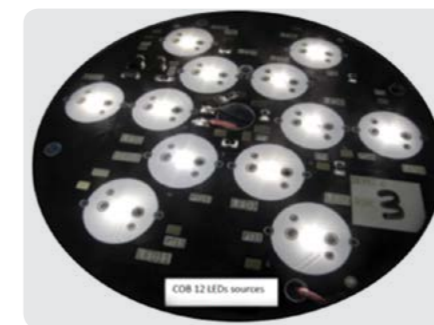
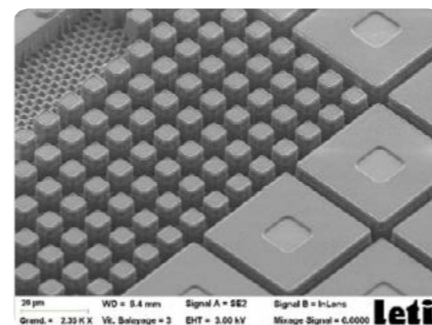
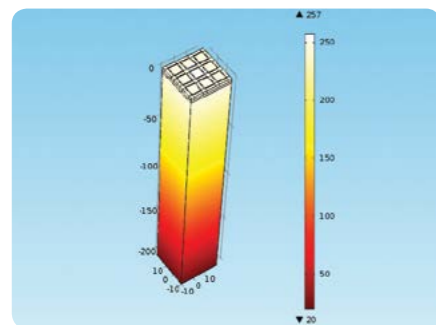
- Quantum dots
- 2D Quantum wells
- Nano grain phosphors

Thermal packaging

- Thermal resistance reduction
- ASIC thinning
- TSV

Active matrix

- High current active matrix fabrication



DESIGN & SIMULATION

- Ray tracing
- Semiconductor structure simulation: Silvaco
- Multiphysics simulations: Comsol
- Light extraction tools

MATERIALS & SUBSTRATES

- LED structure growth on Sapphire or other substrates
- MOCVD growth
- GaN nanowire growth
- Epitaxy on patterned substrates
- Semipolar growth

PROCESS/DIES

- Advanced LED process: VTF, TFFC
- LED array process: pixelation down to 3 μm pitch
- IC silicon active matrix for LED driving
- 10 μm pitch or less connectors
- 3D heterogeneous integration
- Bonding of LED arrays on CMOS active matrices

DEVICES

- High voltage LED chips
- Chip scale packages
- Microdisplays

MODULE

- Smart drivers
- Chip on board
- Smart sensors with embedded electronics

SYSTEMS

- Smart lighting systems:
- Lifi (new advanced communication system)
- Optical Systems:
- Head Mounted displays (HMDs)
 - Head Up Displays (HUDs)

INFRASTRUCTURE

Four InGaN MOCVD epitaxy reactors dedicated to R&D and industrial process development.

Full process line dedicated to III-V compound semiconductors from 2" to 12" wafer (wafer thinning & bonding, etc.)

Device simulation & characterization platform tools: goniometer, light spectrum emission diagram, infrared thermography, etc.

Pilot line for LED die packaging: various technologies (chip to case, chip to wafer, wafer to wafer), LED matrix hybridization, etc.

LETI'S ROADMAP TO HIGHLY SCALABLE PROCESSES

OVERCOMING THE TECHNICAL CHALLENGES OF MULTIPLE APPLICATIONS

To address the different applications, technical challenges have to be overcome. Small pixel size (below 3 μm), color conversion and small pitch hybridization will be essential in the mid to long term. Leti's longstanding know-how and experience in miniaturization and microelectronic processes make it perfectly positioned to take up these different challenges.

SMART LIGHTING

Monochrome LED arrays
10 μm pitch
10⁵ Cd/m²

- Leti's core competencies
- Planar microLED technology
 - micro-tube hybridization
 - Active matrix LED design
 - White conversion



SHORT TERM

HMD PROFESSIONAL

Monochrome LED arrays
10 μm pitch
High brightness: 10⁴ Cd/m²
Resolution: 10⁶ pixels

- Leti's core competencies
- Direct bonding
 - microLED process optimization



HUD AUTOMOTIVE

Color LED arrays
10 μm pitch
Super high brightness: 10⁶ Cd/m²
Resolution: 800 X 500

- Leti's core competencies
- Color conversion



MID TERM

HMD CONSUMER

Color LED arrays
3 μm pitch
Super high brightness: 10⁶ Cd/m²
Resolution: 1920 X 1080

- Leti's core competencies
- Color conversion
 - Direct bonding
 - microLED process optimization



LONG TERM

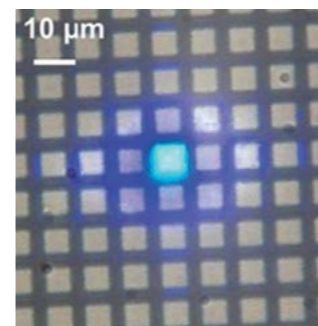
LARGE DISPLAYS

microLED assembly on a large surface

- Leti's core competencies
- Collective pick and place
 - Self assembly



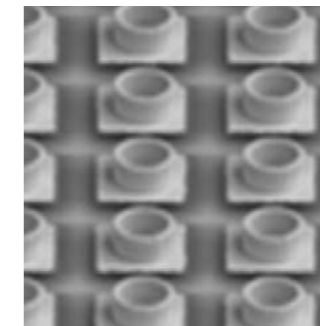
KEY ACHIEVEMENTS



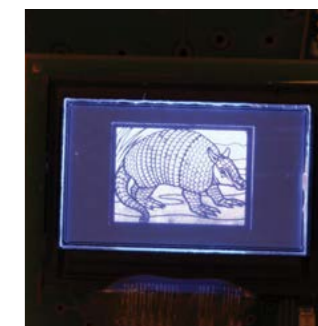
Monolithic LED arrays with a very small pitch (10 μm) and interpitch (2 μm)



Bright enough for a HUD projection system



10 μm pitch hybridization using a Room temperature μtube hybridization technology



Active matrix design: Design and fabrication of dedicated CMOS circuit adapted to GaN microLED arrays control



ABOUT LETI

Leti is a technology research institute at CEA Tech and a recognized global leader in miniaturization technologies enabling smart, energy-efficient and secure solutions. Committed to innovation, its teams create differentiating solutions for Leti's industrial partners.

By pioneering new technologies, Leti enables innovative applicative solutions that ensure competitiveness in a wide range of markets. Leti tackles critical, current global issues such as the future of industry, clean and safe energies, health and wellness, safety & security...

Leti's multidisciplinary teams deliver solid micro and nano technologies expertise, leveraging world-class pre-industrialization facilities.

For 50 years, the institute has been building long-term relationships with its industrial partners providing tailor-made solutions and a clear intellectual property policy.

Leti, technology research institute

Commissariat à l'énergie atomique et aux énergies alternatives

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