UV LASER PROCESSING OF GAN MICROLED´S, A FUTURE PROOF TECHNOLOGY

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COHERENT

COHERENT AT A GLANCE

FROM A FOUNDATION OF MATERIALS AND IMAGINATION, WE ENABLE EXCITING MEGATRENDS

1971	Year Founded	**COHR**	Nasdaq
28,000+	Employees(2)	**$4.8 B**	FY22 Revenue(1)
4,400+	Engineering & Technology Employees(2)	**$65 B**	Available Market(2)
3,000+	Patents(2)	**130**	Locations
VERTICAL INTEGRATION	Materials, Components, Subsystems, Systems and Service	**24**	Countries

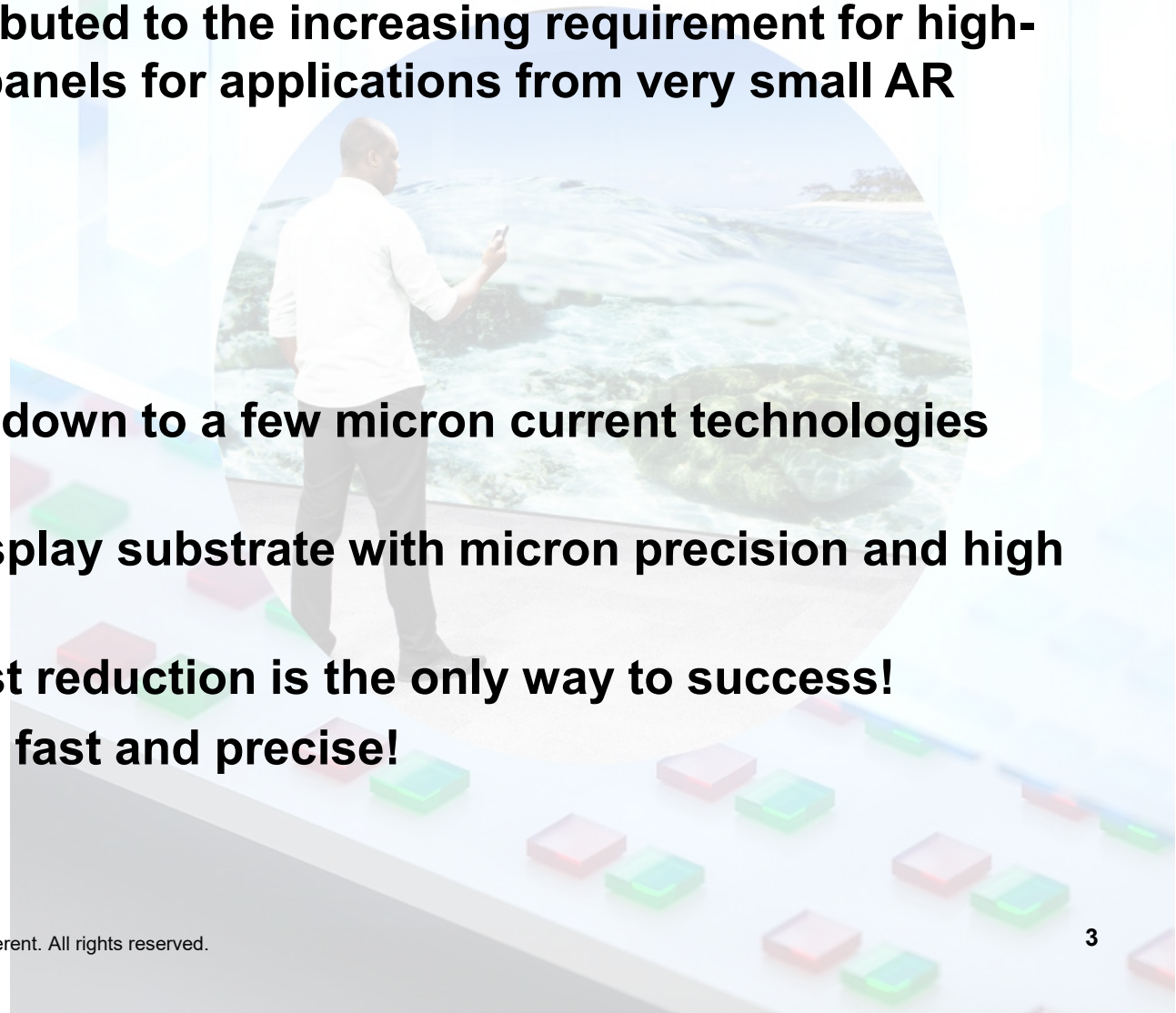
(1) Proforma non-GAAP revenue combines II-VI FY22 revenue (as of FYE 6/30/22) and Coherent 6/30/22 TTM. Not calculated in accordance with Article 11 of SEC regulation S-X.
(2) As of July 1, 2022

MICROLED DISPLAY MARKET

The growth of the MicroLED market can be attributed to the increasing requirement for high-brightness and low-power consuming display panels for applications from very small AR displays to very large TV´s

Challenges in MicroLED Display Manufacturing

- **Laser Lift-Off – roadmaps showing die sizes down to a few micron current technologies running into issues**
- **Processes to transfer the dies to the final display substrate with micron precision and high productivity and yield**
- **To make MicroLED displays competitive, cost reduction is the only way to success!**
- **Your processes and technologies need to be fast and precise!**
- **Laser solutions are the key to success!**



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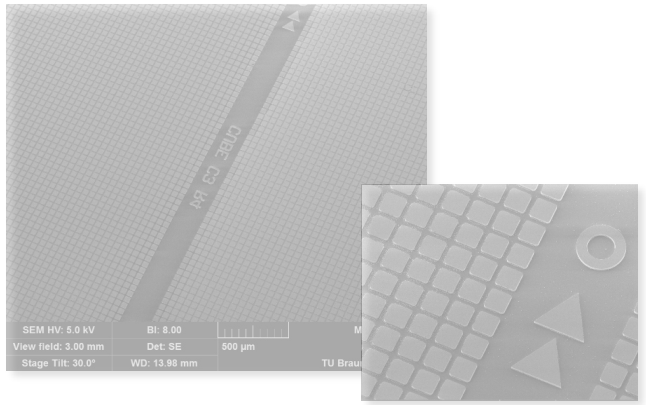
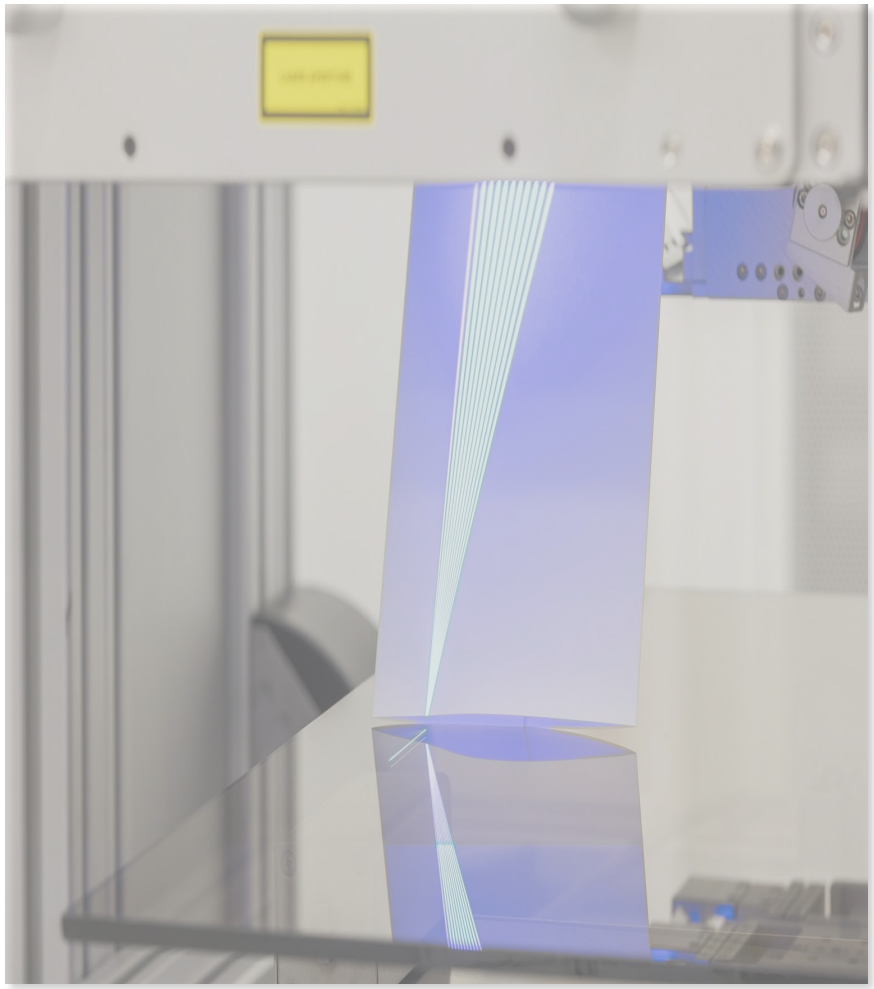
MICROLED LASER PROCESSES

- Laser Lift-Off
- Laser Induced Forward Transfer
- Laser Repair
- Laser Annealing of LTPS-TFT
- Laser Assisted Bonding
- Laser Cutting of Glass / Flexible Substrates



Advantages of Lasers for MicroLED Processing

- selective
- touchless
- high speed
- micron precision



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MICROLED LASER PROCESSES

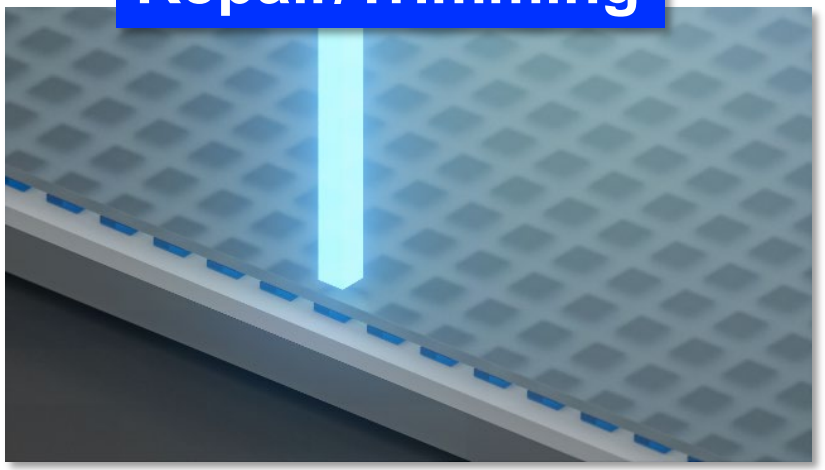
Laser Lift-Off

- Optimized beam geometry to any MicroLED size and geometry

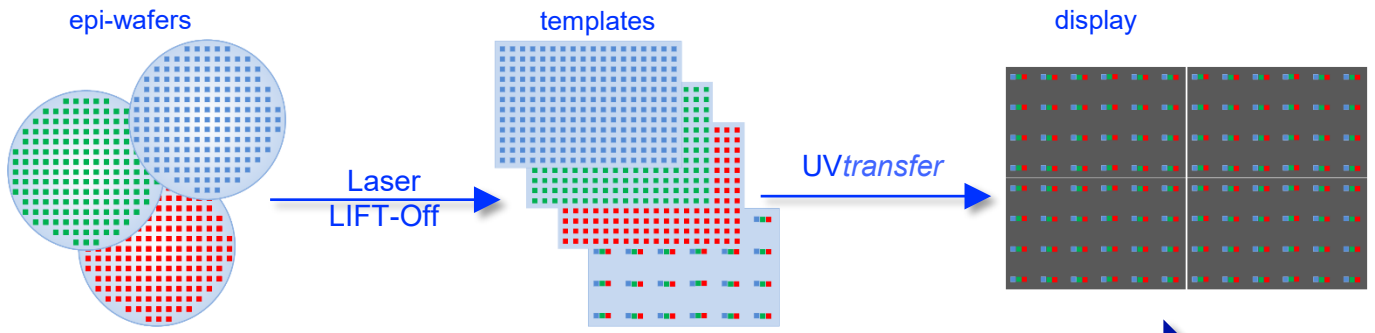
UV*transfer*

- Transfer MicroLED´s from the growth wafer or a temporary carrier – changing the pitch!

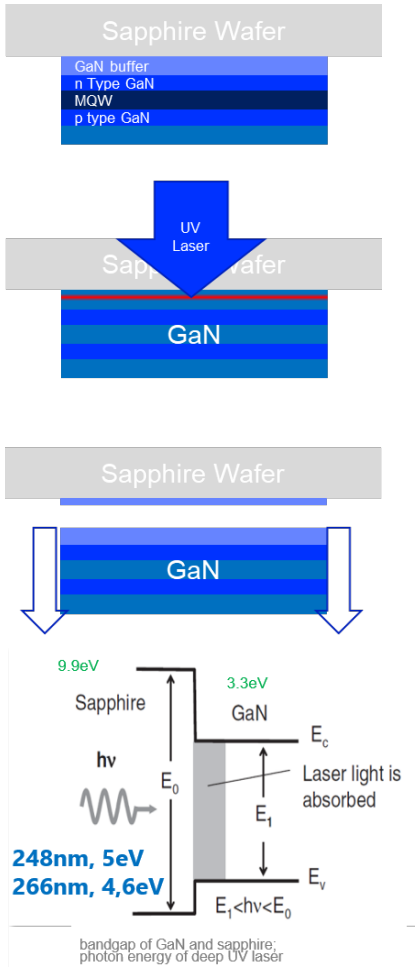
Repair/Trimming



- Processing of individual MicroLED´s – remove and refill

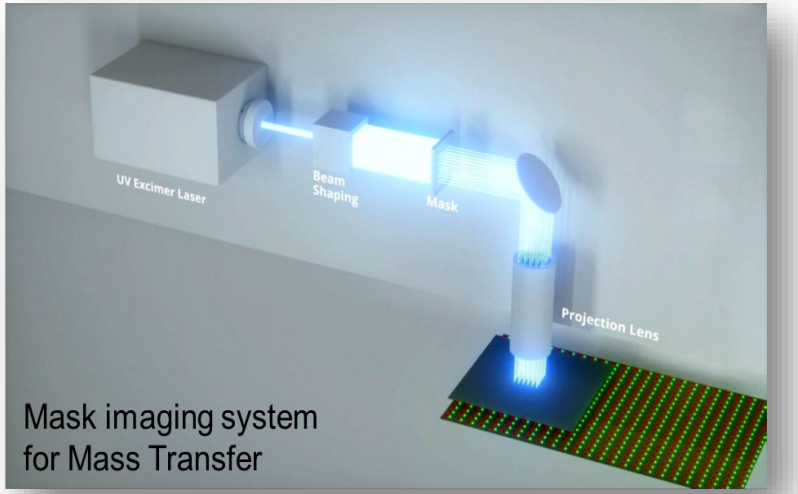


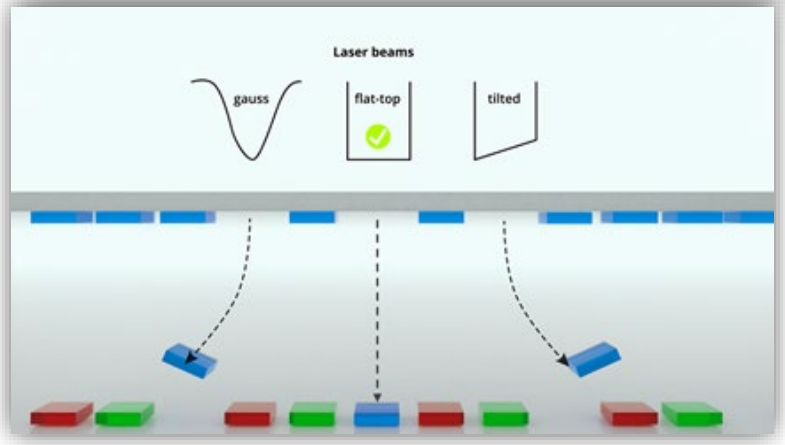
LASER AND OPTICS BY COHERENT – DEEP UV AND MASK IMAGING SYSTEM



DUV laser wavelength with direct linear absorption in the LED-material (GaN)

- ► Low thermal impact
- ► Minimal particle generation
- ► High surface quality of LEDs after exposure





Mask imaging Systems

- High resolution
- High homogeneity and edge steepness
- Individual masks to adapt to wafer layout and MicroLED sizes
- ► Ideal solution to transfer MicroLEDs in an industrial scale

It all starts with the right wavelength and a perfect beam shaping

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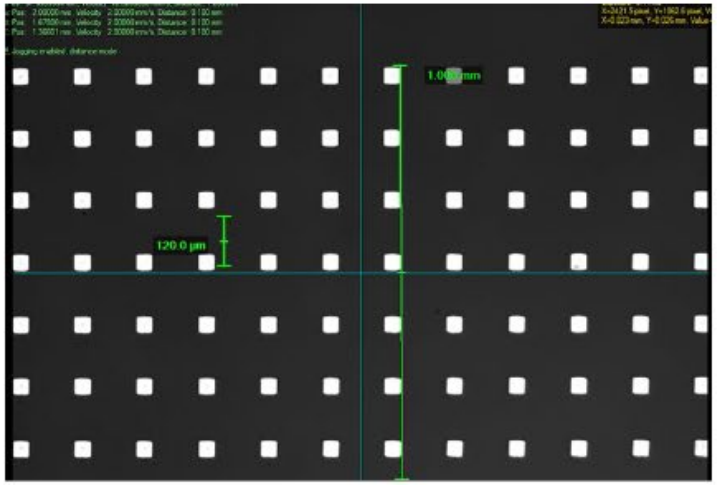
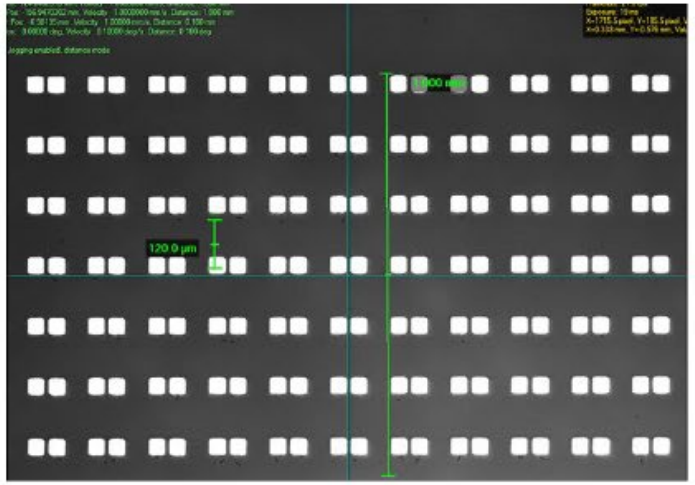
PROCESS RESULTS MASS TRANSFER

MICROLED RGB TRANSFER

1st shot



2nd shot



3rd shot

GaN RGB MicroLED´s
40 x 40 µm², 10 µm SW
Pitch red to red 150 µm

SW – Street Width

Energy Density 800mJ/cm²
Distance between Donor and Receiver 80µm
Receiver – Adhesive on Quartz

UVtransfer Process –Mass Transfer of Single Colour 40x40µm² MicroLED´s

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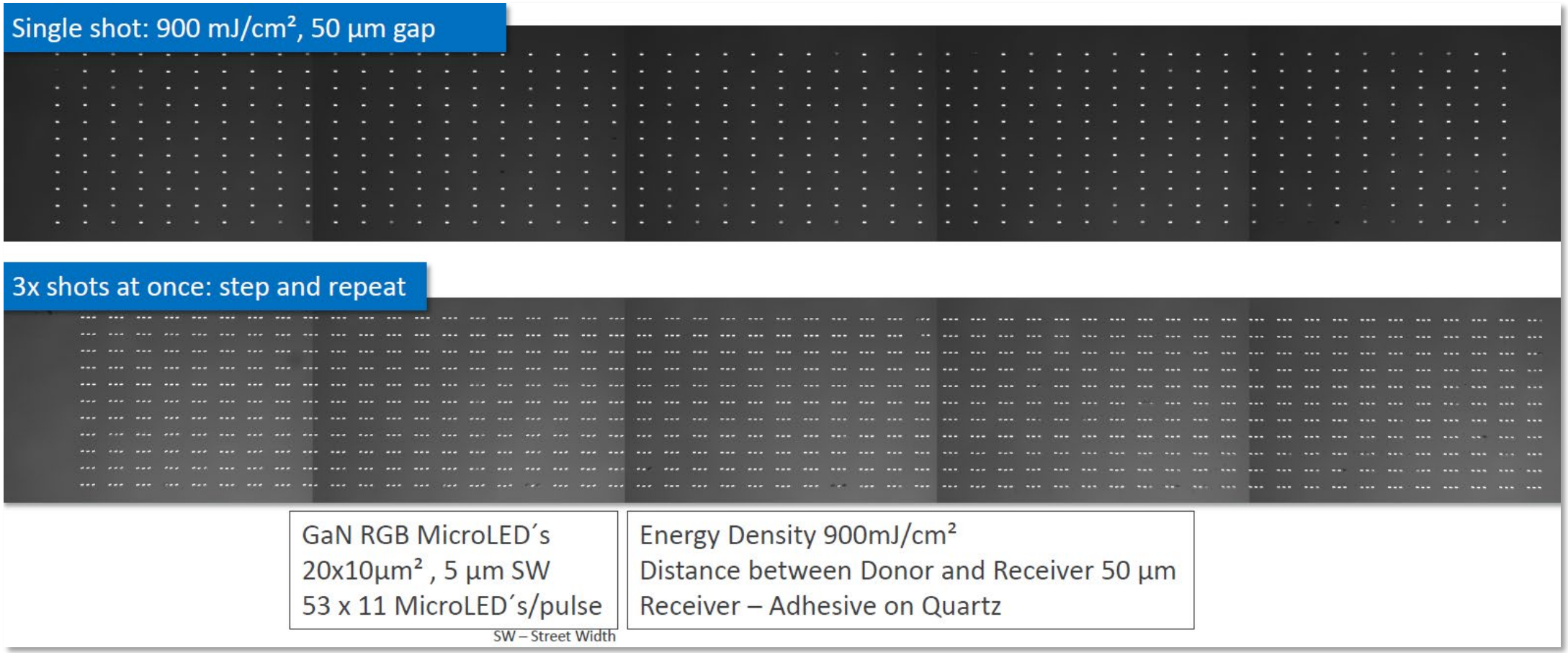
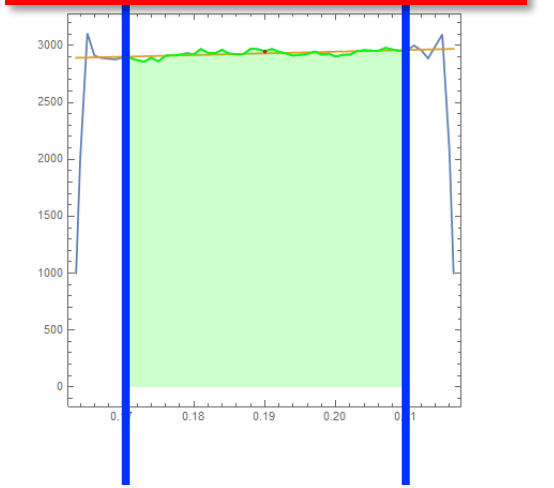
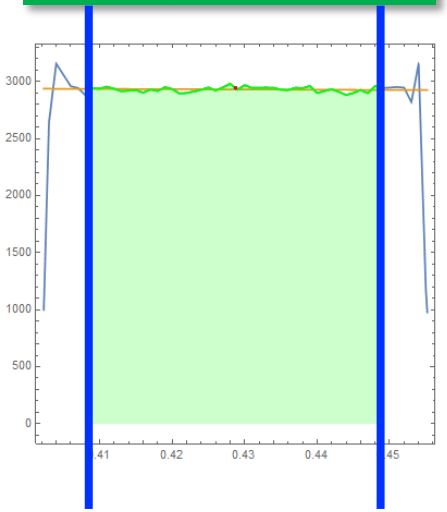
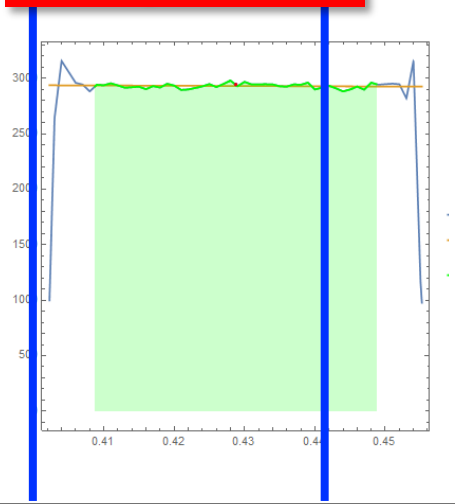
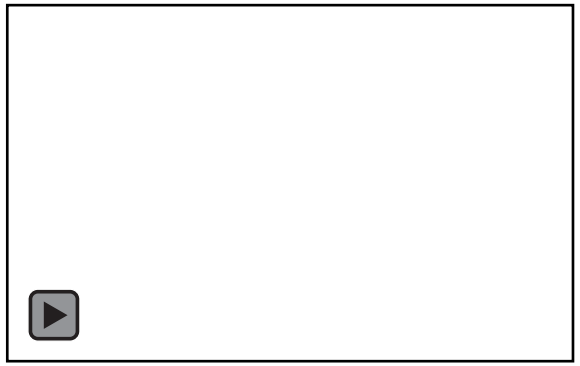
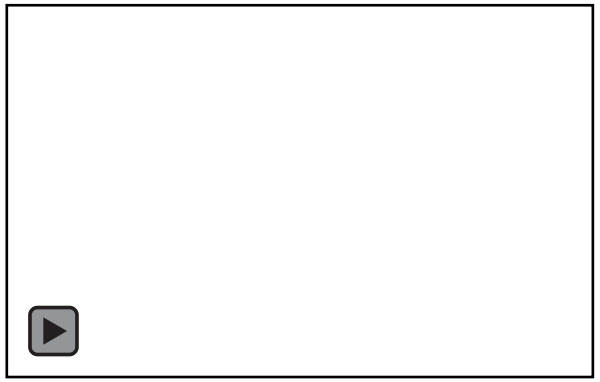
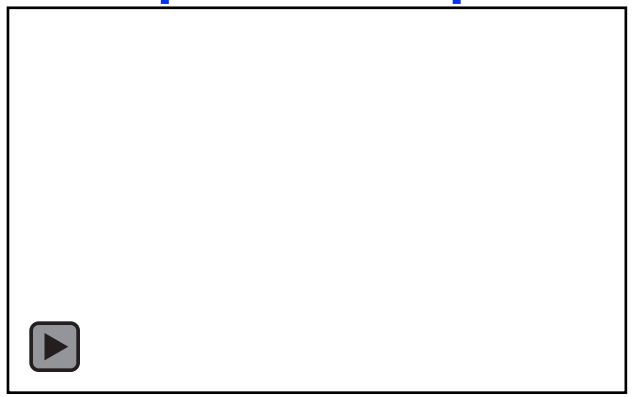
PROCESS RESULTS MASS TRANSFER

MICROLED RGB TRANSFER



UVtransfer Process –Mass Transfer of Single Colour 20x10µm² MicroLED´s

TRANSFER PROCESS SIMULATION TO VERIFY THE BEST OPTICAL BEAM PARAMETER

	Insufficient Homogenized Beam	Homogenized Beam	Misaligned Beam
Measurements as Input			
Simulation Output			
	→significantly inclined state on impact	→almost no inclination on impact	→ obvious inclination on impact

Global Coherent team effort to simulate the dynamic transfer process

OUR CUSTOMERS HAVE THE CHOICE - LASER, OPTICS, TURN-KEY SYSTEM

COHERNT VERTICAL INTEGRATION

Laser

- DUV Lasers established for MicroLED processing
- Reliable industrial laser sources at different energy levels
- Scalable power

OEM System

- Laser + Optics designed on customer requirements
- Standard configurations available
- Mask Imaging and Line Beam systems

Turn-Key Solution

- UV*transfer* Turn-Key 248 nm System
- Laser, Optics, Stages, Imaging, Software
- Designed for industrial customers

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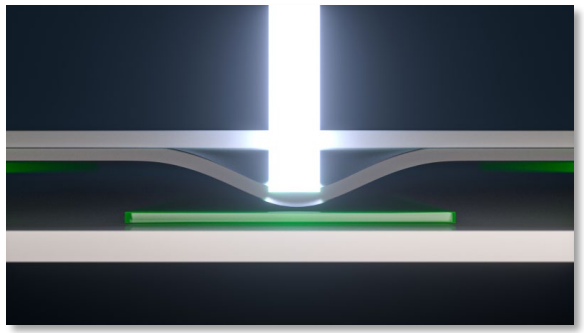
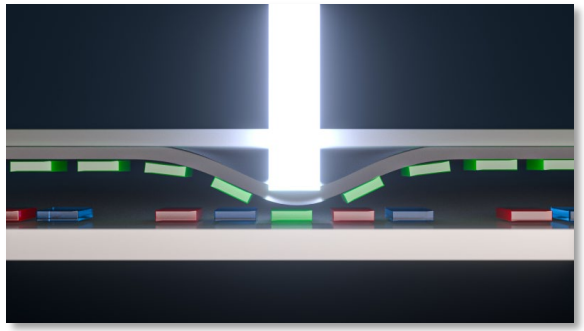
OUR LASER SOLUTION IS FUTURE PROOF

Laser + DRL*

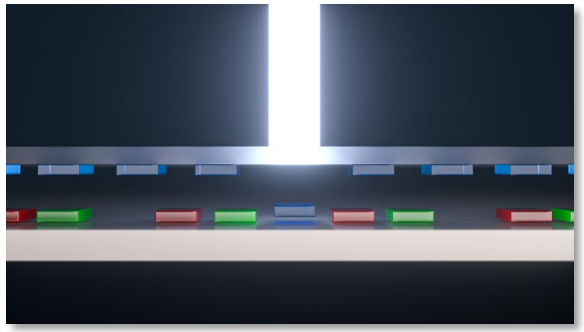


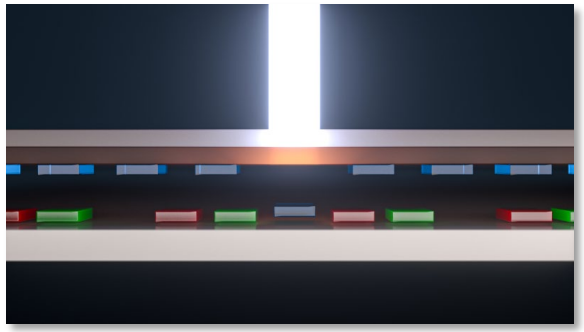
MiniLED OK



MicroLED NOK

248nm Laser Coherent

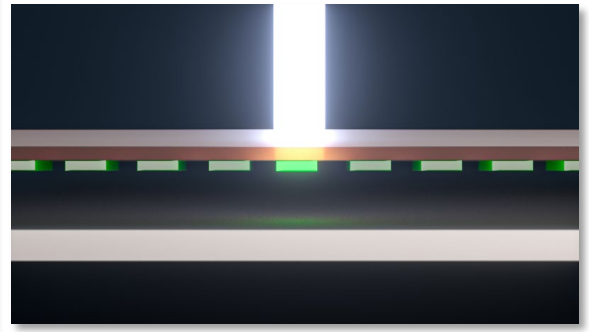


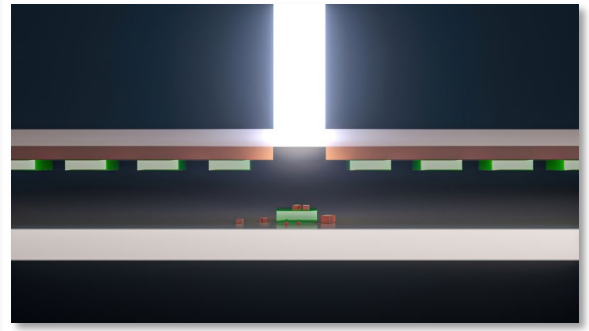


Coherent High Resolution Mass Transfer

- OK to transfer directly from EPI wafer
  - Selective transfer or bulk transfer (LLO)
- OK to transfer from temporary carrier with transparent adhesive w/o damaging the surface of the MicroLED

Longer λ + Glue





Residue – low yield NOK

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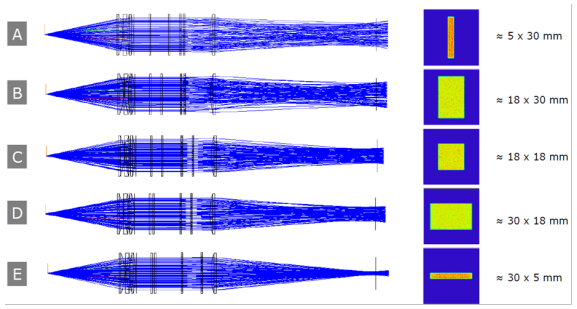
*DRL Dynamic Release Layer

OUTLOOK MICROLED - LASER ASSISTED BONDING (LAB)

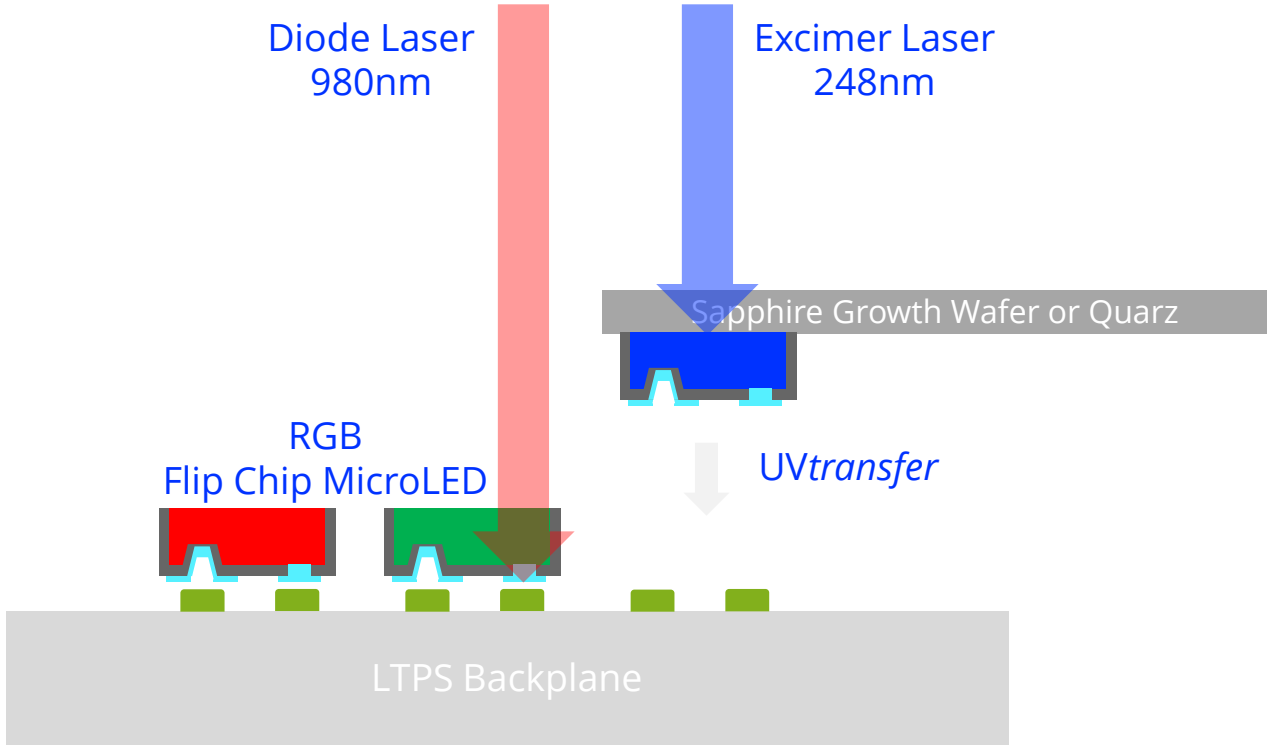
Laser Assisted Bonding

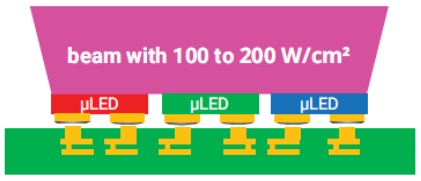
- less thermal budget
- + selectivity
- + less warpage
- + 980 nm diode laser wavelength transparent for GaN MicroLED´s
- + homogenized large area beam for high throughput



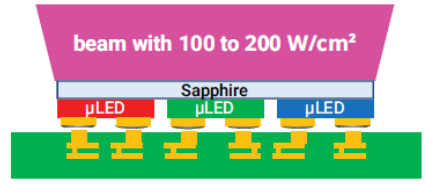
Example: 35 x 4mm²

Edge steepness: ~1.2 mm (10-90% intensity)





0.1-0.6s exposure (depending on soldering material)



0.1-0.6s exposure (depending on soldering material)

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THANK YOU FOR YOUR ATTENTION

Questions?


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