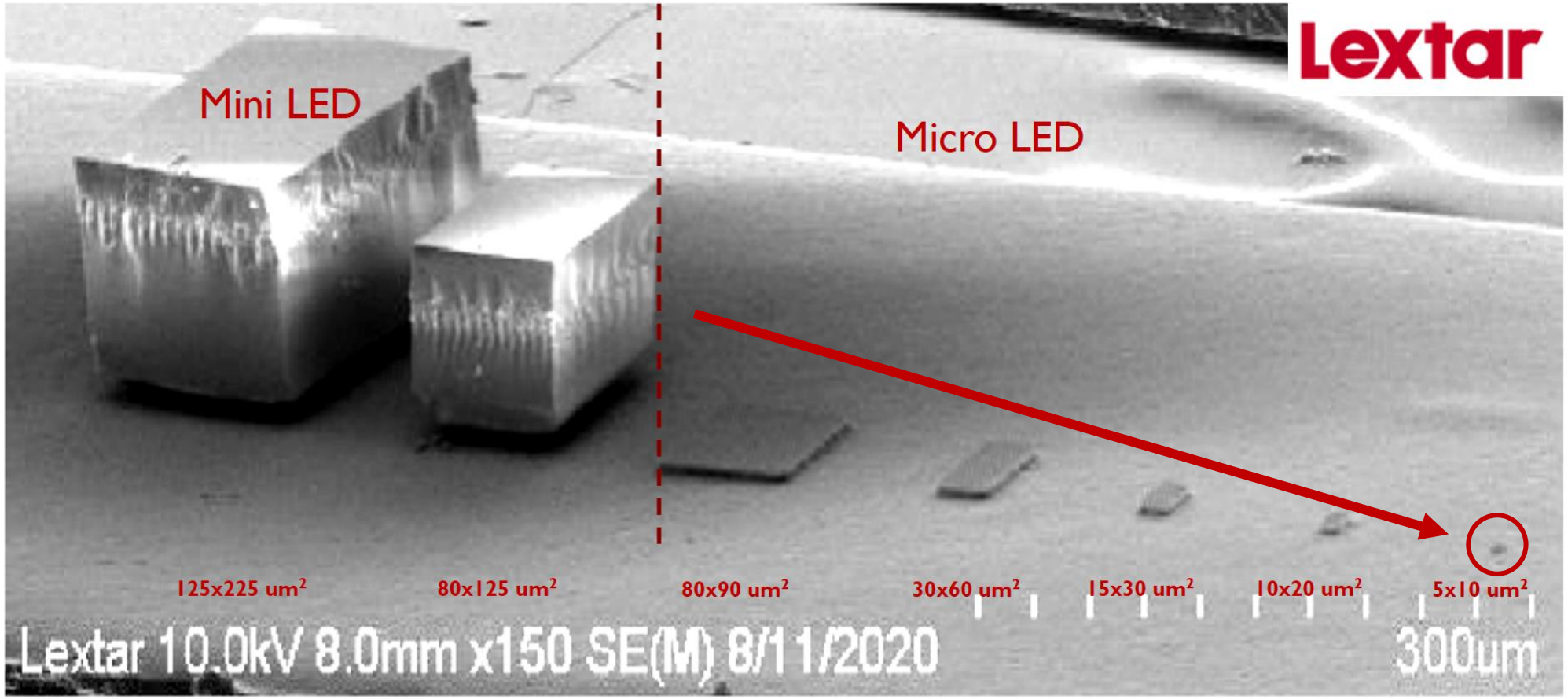
Micro Transfer Printing (MTP) for Photonics

Tiny Heterogenous Components Integrated on a Single Substrate

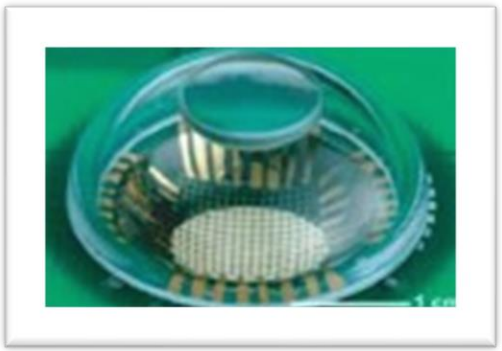
Presenter
Event
Date

Tiny Components Make MTP Possible



Now the Possibilities are Endless

ELECTRONIC EYE CAMERA



Compressible silicon optoelectronics printed onto a hemispherical glass lens substrate for use as the world's smallest fisheye camera

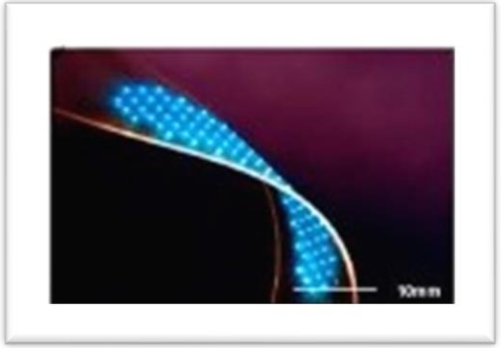
BENDABLE PHOTOVOLTAICS

Bendable arrays of silicon solar microcells printed on foreign substrates to enable self-powered sensors, servos, and signals everywhere

IN VIVO SENSORS

In vivo sensors used in integrated balloon catheters for heart mapping and ablation, as well as glucose or blood pressure monitoring

FLEXED LED ARRAY



Ultrathin microscale blue LEDs printed on flexible plastic for untold illumination and signaling applications

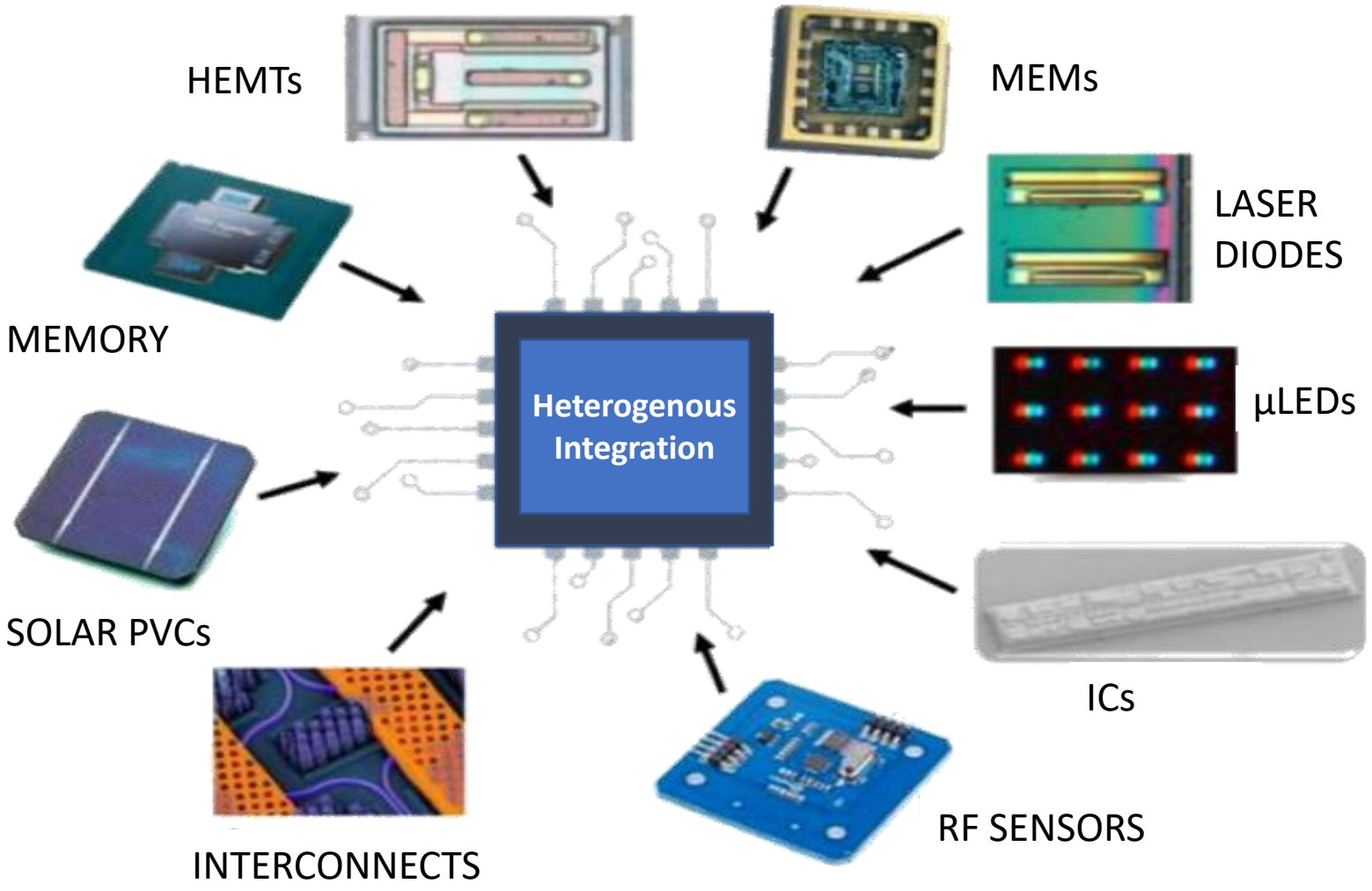
Source: https://www.nature.com/articles/s41528-018-0037-x.pdf

Everyone Agrees

“What the industry needs are micro-devices from a variety of source wafers micro-assembled on a non-native substrate.”

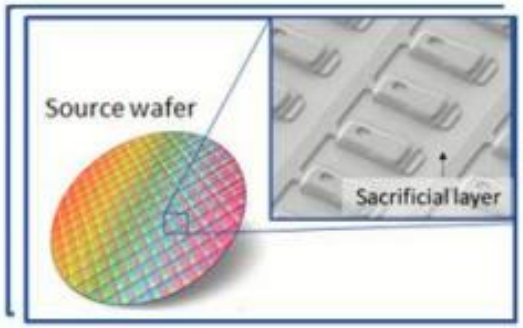
(Exactly what we do)

Micro Transfer Printing Capabilities

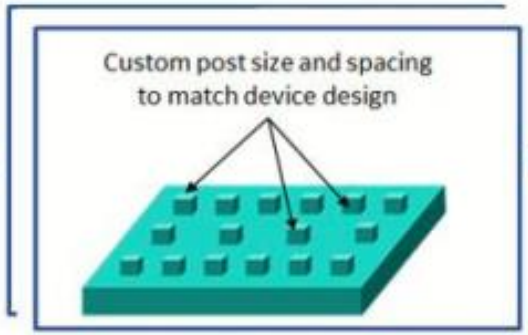


Heterogeneous Integration 101

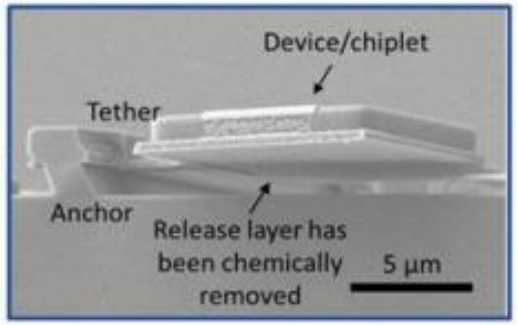
Step 1: Fabricate x-chip devices with sacrificial under layer and tether system.



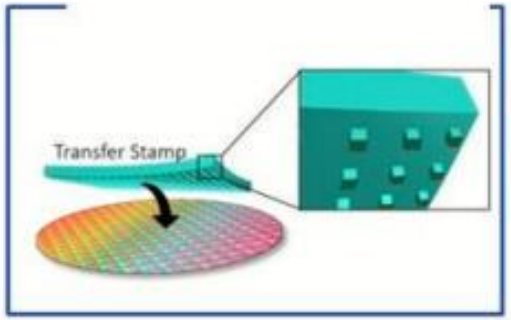
Step 2: Create custom tailored stamp to transfer devices



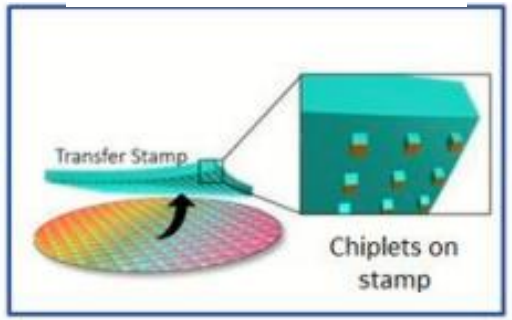
Step 3: Chemical etch of sacrificial layer on source wafer, creating suspended devices.



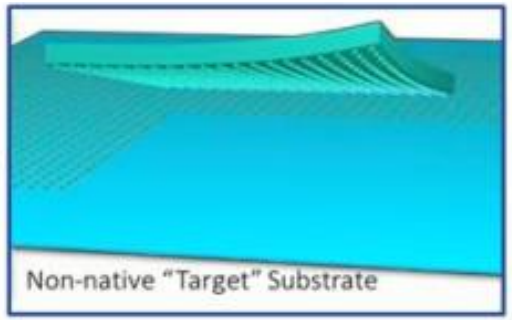
Step 4: Align stamp with devices to be transferred.



Step 5: Lift stamp and break tethers, removing devices.

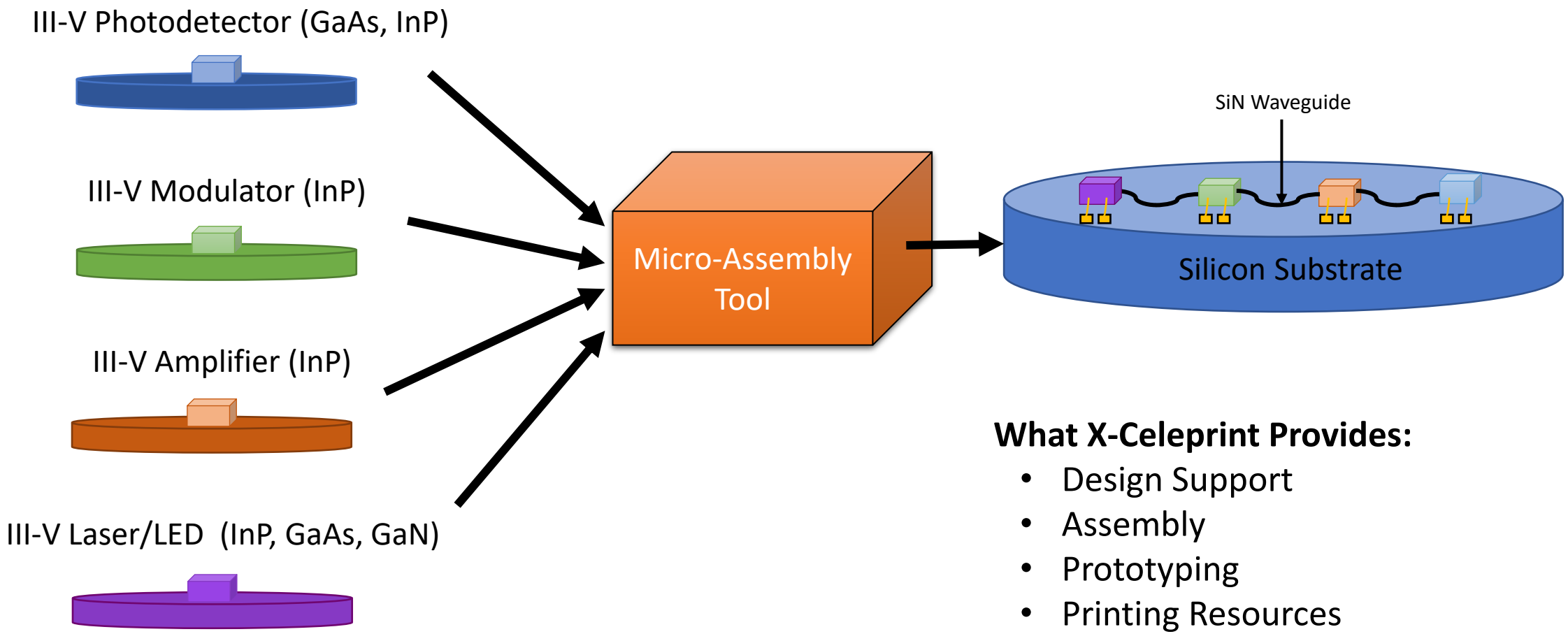


Step 6: Stamp contacts target wafer and transfers devices.



Repeat for as many devices or designs as needed.

Fully Assembled Solution



What X-Celeprint Provides:

- Design Support
- Assembly
- Prototyping
- Printing Resources

Compare the Specs

Less Waste & Minimal Packaging = Lower Cost & Increased Efficiency

	Flip-Chip State-of-the-Art	MTP	Improvement with X-Celeprint
Minimum chiplet size	500 µm x 500 µm	< 5 µm x 5 µm	**>10,000x smaller area**
Chiplet spacing	100 µm	~ 10-20 µm	**~ 10x tighter spacing**
Chiplet thickness	100 µm	< 1 µm	**>100x thinner**
Chiplets assembled per die	2 - 100	>1,000	**>10x higher density of equivalent-sized chips**
Throughput	1 chiplet at a time	60,000+ chiplets at a time	**60,000x more efficient**
SWaP – Array size and weight	-	30,000 x 30,000	**Up to 10^2-10^6x smaller overall footprint**

Client Projects

Industry: Manufacturing?
Location: Germany?
Final Product: Device?

- VCSEL and photodiode integration
- 83 um x 83 um VCSEL
- ~1000 transferred / minute - in pilot stage
- **Densely integrated system**

Industry:
Country:
Final Product:

- Laser integration to Si waveguide
- 80 um x 350 um Laser
- ~750 transferred / minute, nearing production
- **Low volume / low-mass device**

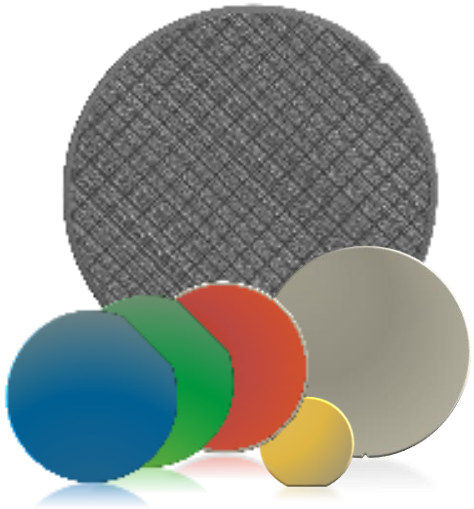
Industry:
Country:
Final Product:

- Laser and acoustic modulator on Si waveguide
- 950 um x 126 um Laser
- ~15 transferred / minute - in pilot stage
- **III/V integration with Si**
  - Product size
  - Source utilization

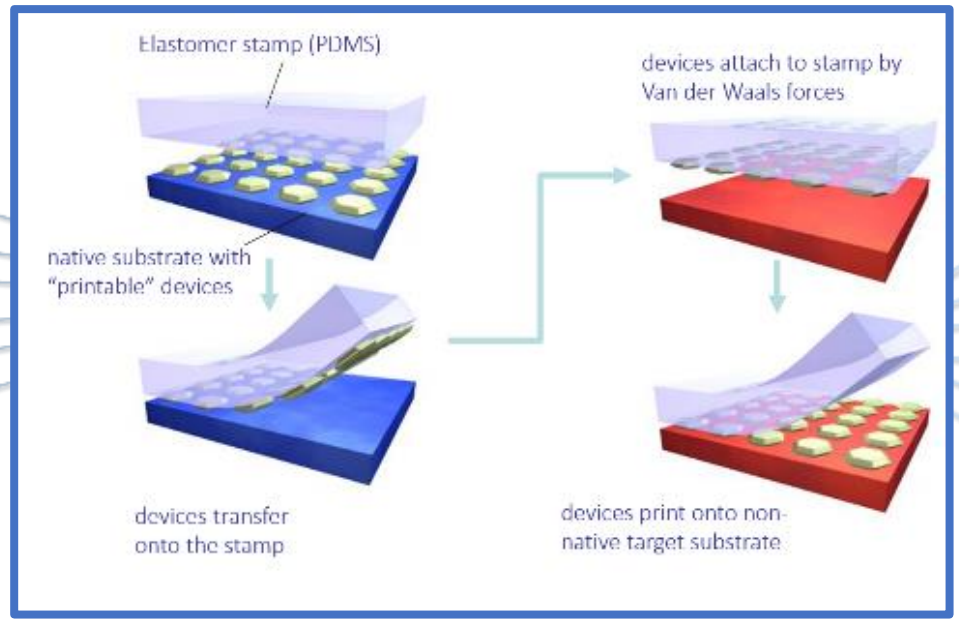
All aligned with <1.0 um 3-sigma accuracy

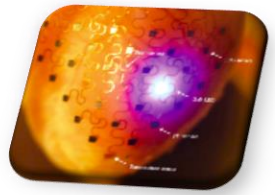
Micro-Assembly for Wafer Fab Devices

Less Waste | Minimal Packaging | High Efficiency | Lower Cost | Faster to Market



Wafer Fabricated Devices
Single-crystal
Fine lithography
(ICs, LEDs, Lasers, etc…)

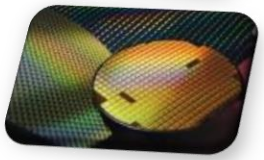



Plastic

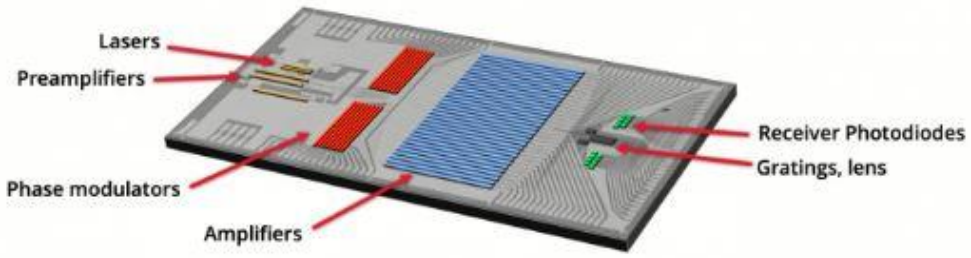

Glass


Ceramic


Paper


Other Semiconductors

Thank You. Questions?



Photonic Integrated Circuit (PIC)

Contact Us

- info@xceleprint.com
- Visit our website https://x-celeprint.com
- We're always available to answer any questions that come up after the presentation.

About X-Celeprint

- Headquarters in Ireland and U.S.
- 625 patents and applications held globally
- Services:
  - Design Support
  - Assembly
  - Prototyping
  - Printing Resources
- 20+ printers world-wide from X Display Company and ASM/Amicra
- XX number of current customers around the globe
- Contracts with the government, academia and many commercial companies