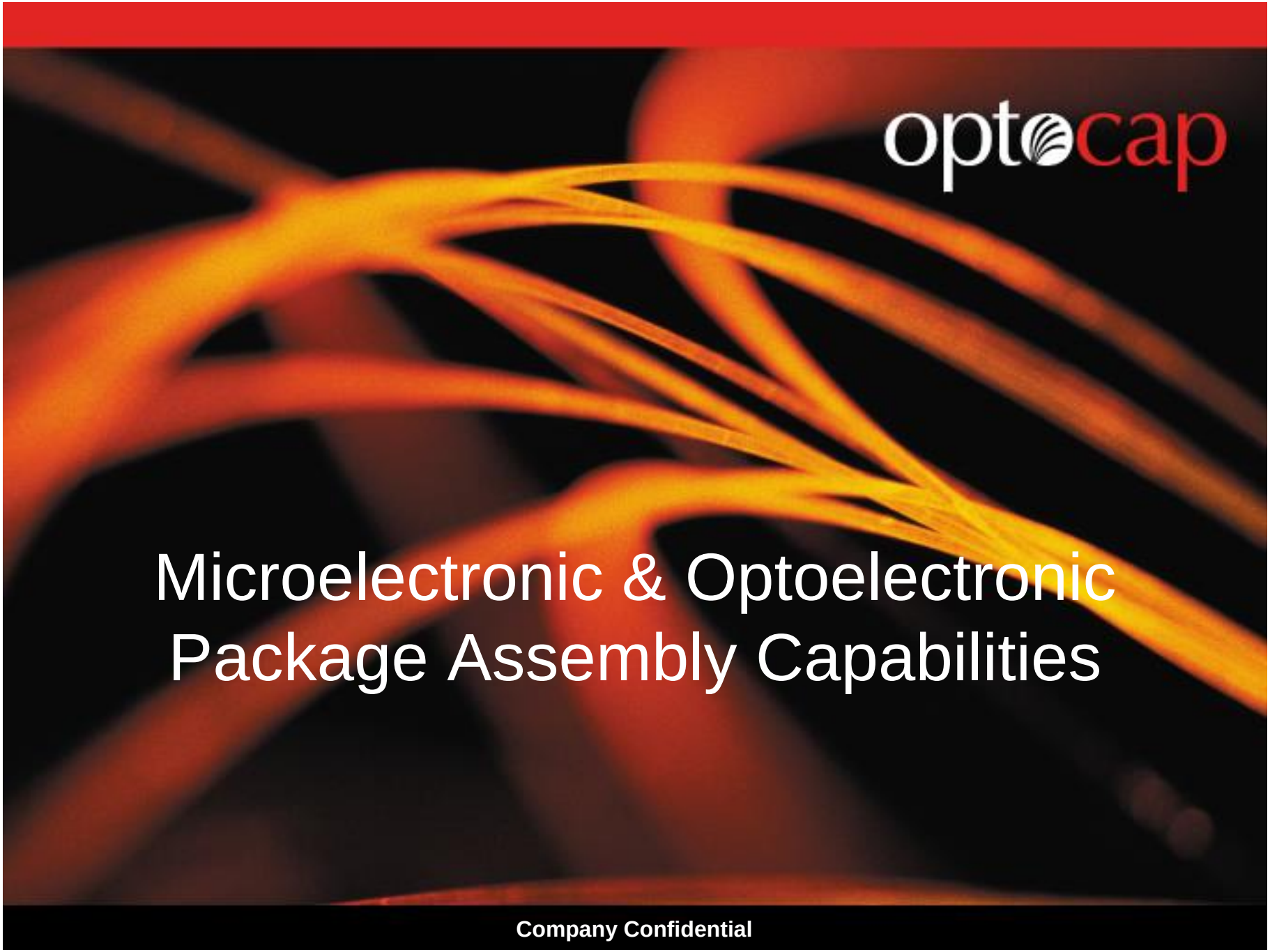

optocap
Microelectronic & Optoelectronic
Package Assembly Capabilities
Company Confidential

- **Company History**
  - Markets and Services
- Design & Assembly Capabilities
- Case Study: Compound Semiconductor Photonic module design & manufacture

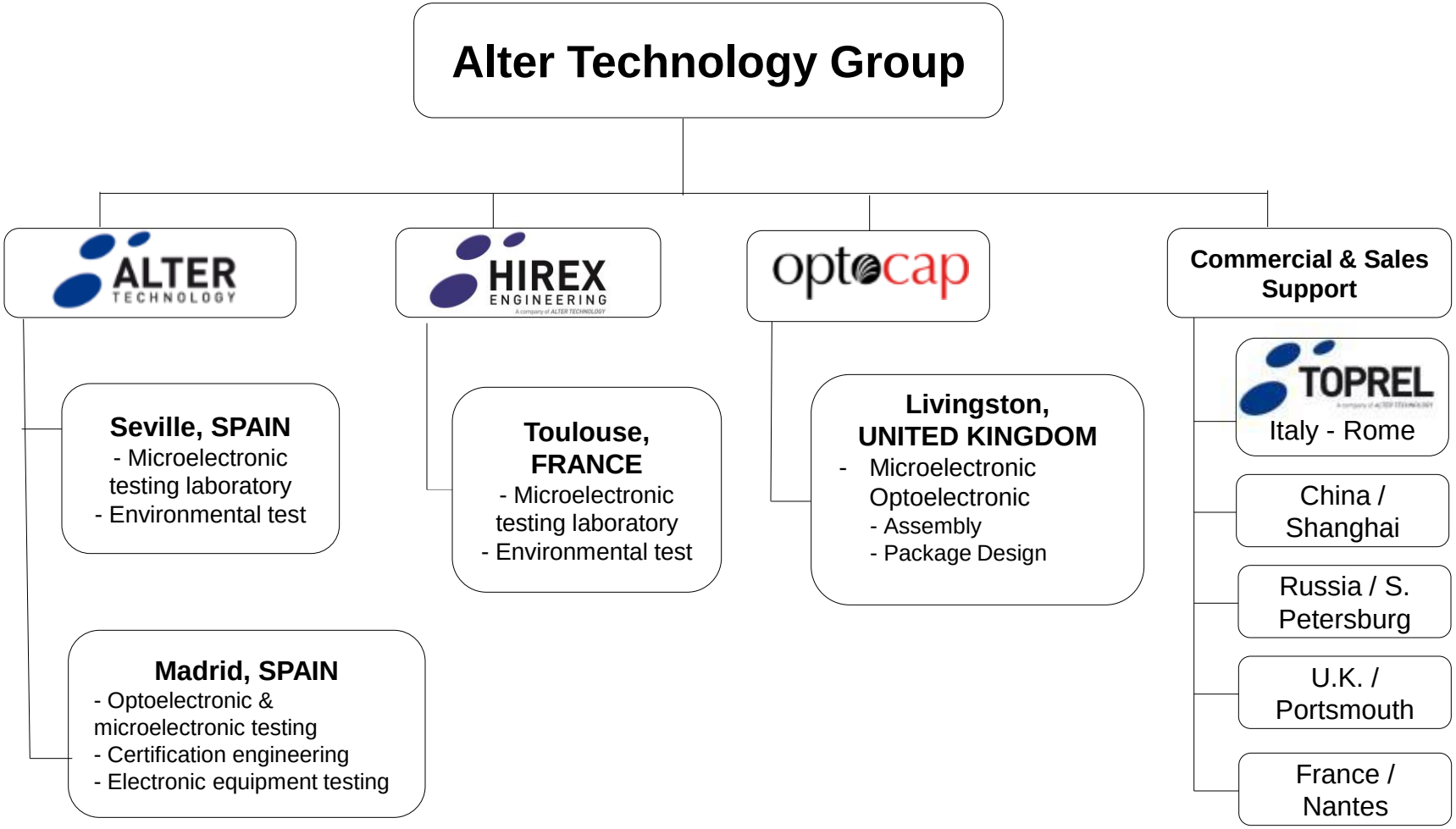
Company History

2003 – Optocap Established

- Packaging services
- Customers
  - Start-ups & Spin-outs
  - Universities
  - Small and Medium Enterprises
  - Multinationals & Space Agencies

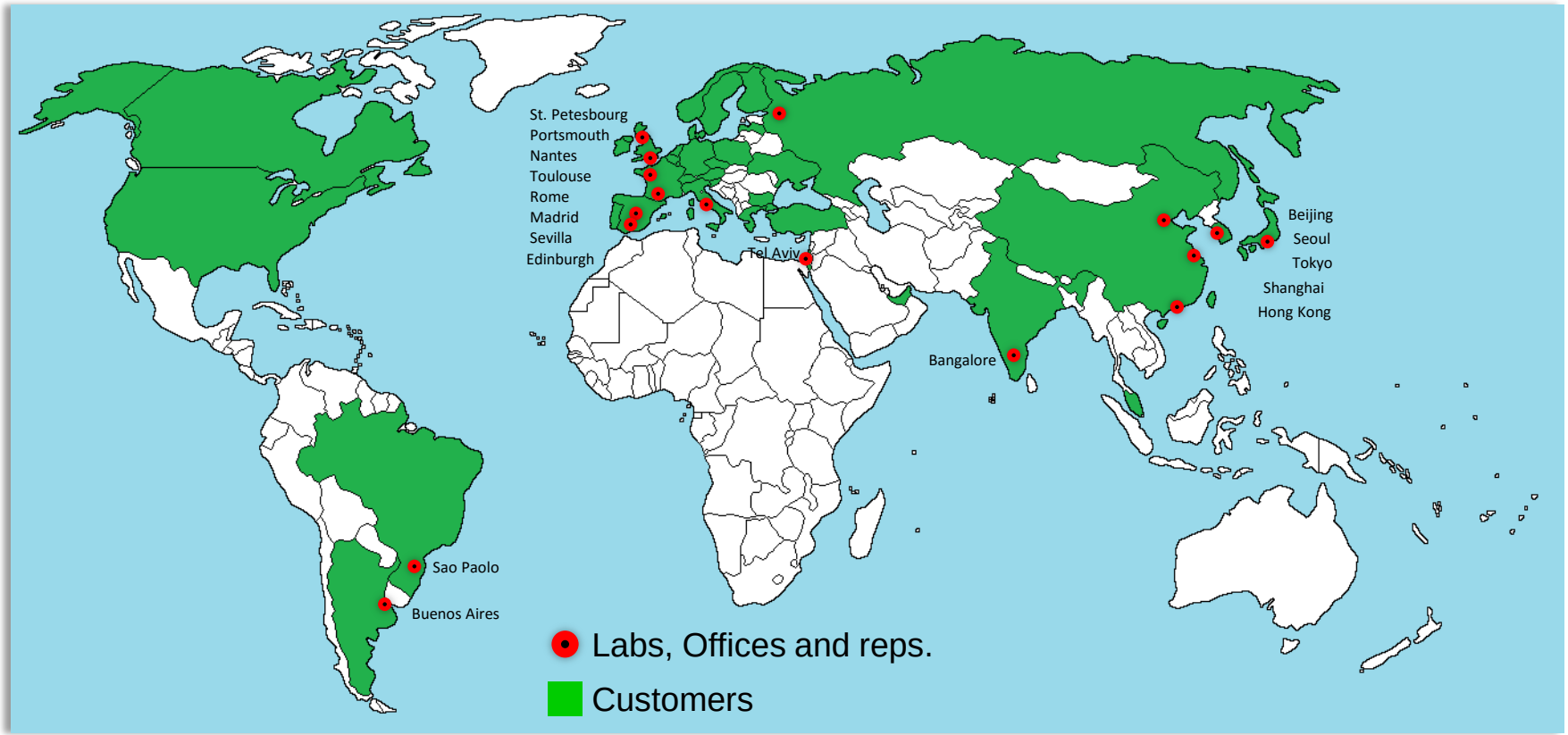
2016 – Acquisition by Alter Technology TUV Nord SAU

- IC Test services
  - Packaged devices
  - Wafer level


Alter Technology Group
ALTER TECHNOLOGY
HIREX ENGINEERING
optocap
Commercial & Sales Support
Seville, SPAIN
- Microelectronic testing laboratory
- Environmental test
Madrid, SPAIN
- Optoelectronic & microelectronic testing
- Certification engineering
- Electronic equipment testing
Toulouse, FRANCE
- Microelectronic testing laboratory
- Environmental test
Livingston, UNITED KINGDOM
- Microelectronic Optoelectronic
- Assembly
- Package Design
TOPREL
Italy - Rome
China / Shanghai
Russia / S. Petersburg
U.K. / Portsmouth
France / Nantes

Group Presence & Customers

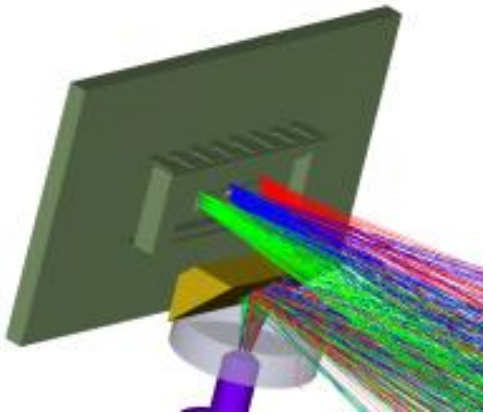
(markets & services)



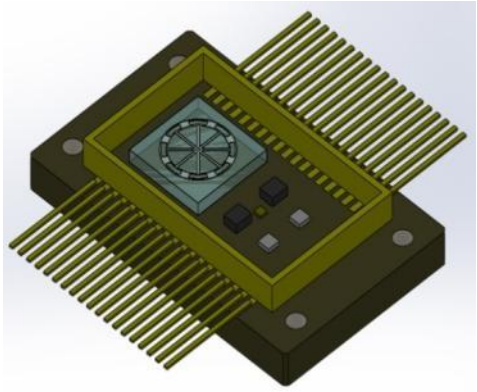
- Company History
  - Markets and Services
- **Design & Assembly Capabilities**
- Case Study: Compound Semiconductor Photonic module design & manufacture

Design Capability

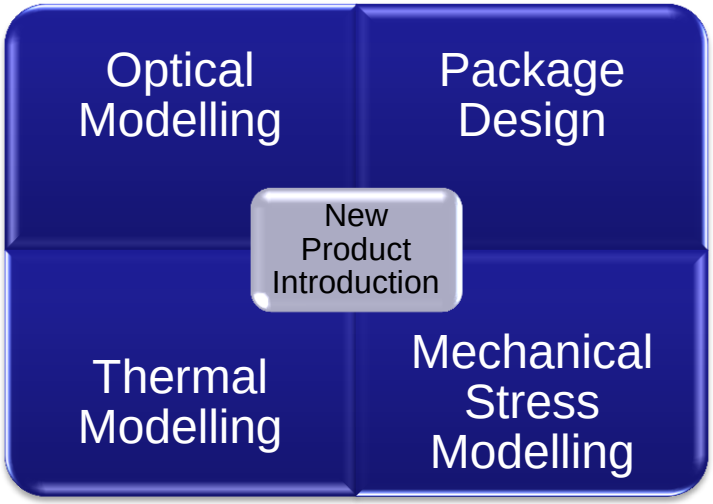
Optoelectronic &
Optical Packaging

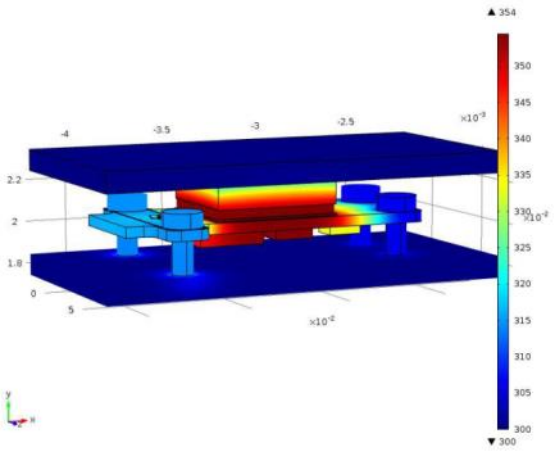


Hi-Reliability
Packaging

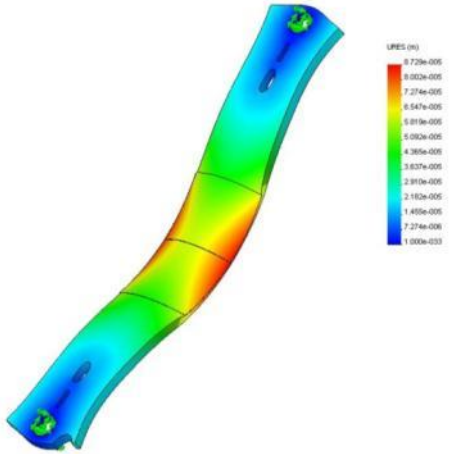


Design for
Manufacture

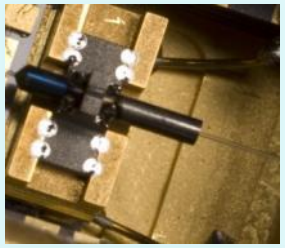


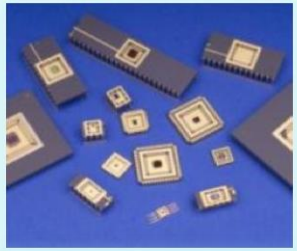


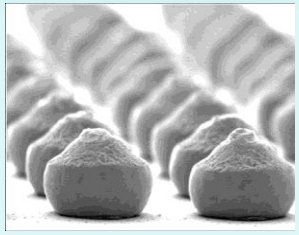
Microelectronic &
MEMS Packaging

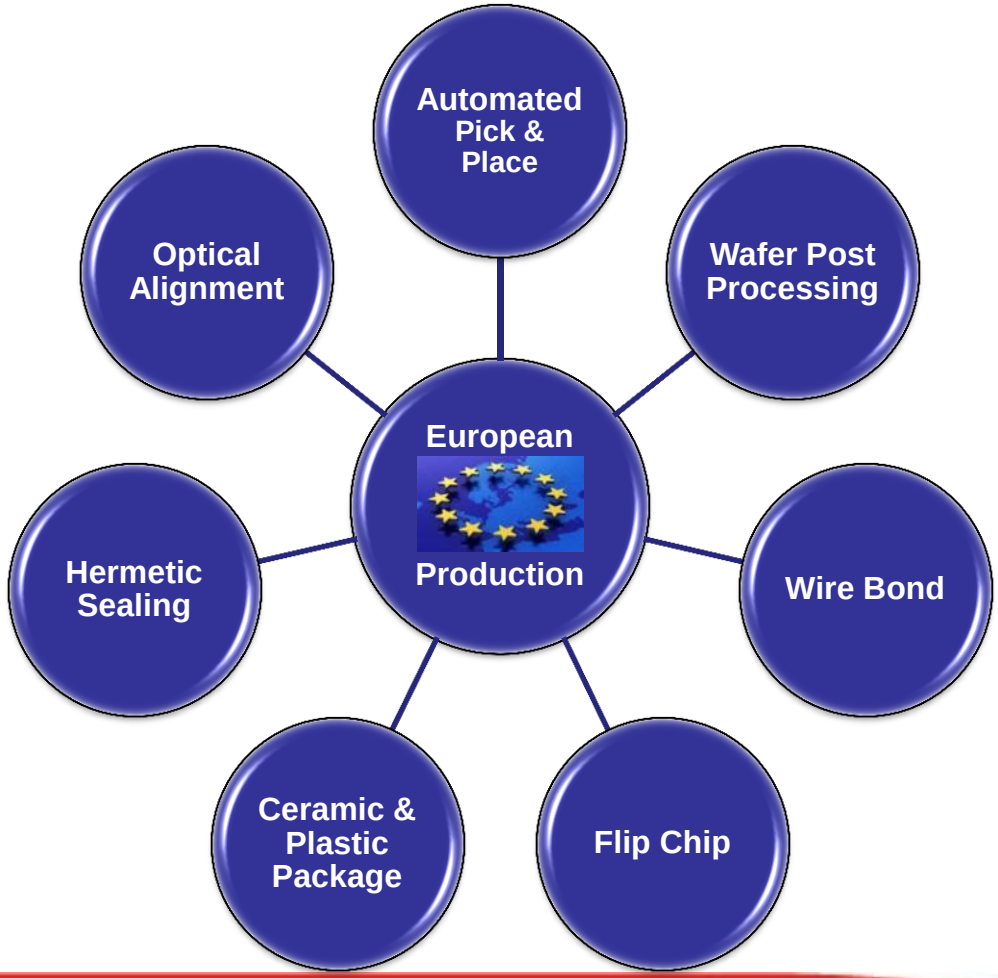


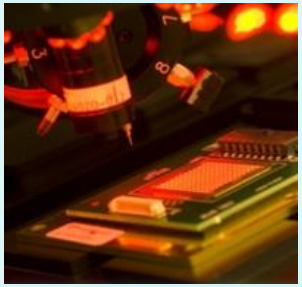
Assembly Capability

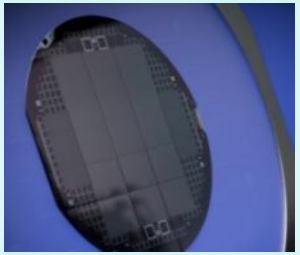






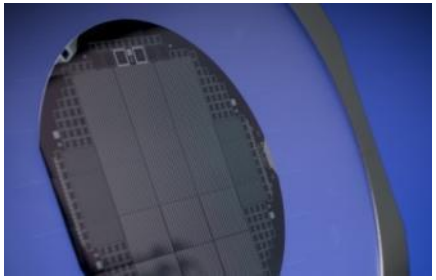




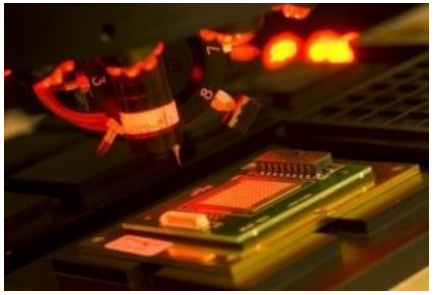


Assembly –Wafer Saw and Die Attach

- **Wafer Dicing**
  - Up to 8” substrates
  - Si, GaAs, GaN, FR4, Glass, Laminates, Ceramics
  - Multi-Project Wafers (MPW)
  - Singulation of wafers from 100microns to a few mm’s
  - Optimised processes for MEMS and Sensor devices



- **Die Attach**
  - Pick from Gel, Waffle and Wafer (Die sizes from few 100’s µm to few 10’s of mm)
  - Work to MIL-STD-883 as default
  - Fully automated die attach processes
  - Placement accuracy from +/-1µm to +/-12.5 µm

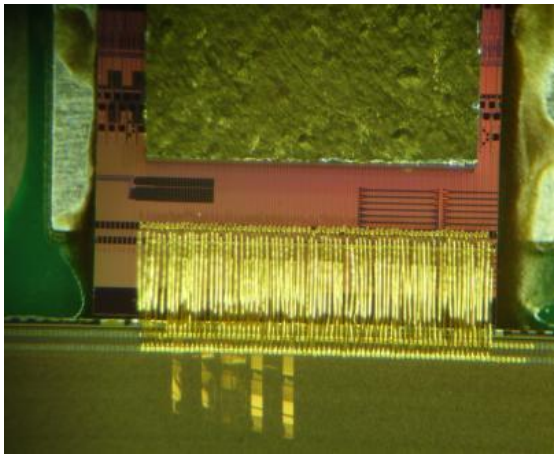


  - Range of Solder attach processes
    - Soft and Hard Solders (SAC, SnPb, In, AuSn, AuSi)
    - Flux and Fluxless processes
    - Screen print, solder dispense and solder preforms

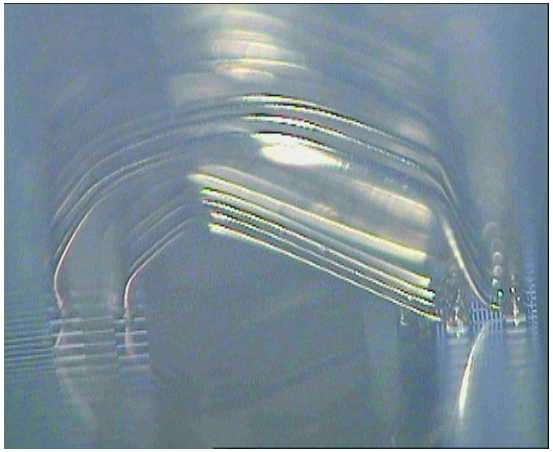
  - Wide range of Conductive and Non-Conductive Epoxies
    - Epoxy dispense and Epoxy stamping process
    - Thermal and UV cured epoxies

Assembly – Wire Bonding

- **Au Ball Bonding**
  - 17um to 33um Au wire diameter
  - Wire bond down to 50um pitch
  - Demonstrated 25um interleaved across 512 channel array
  - Die to Die Bonding
  - Reverse bonding
  - Double sided Bonding
  - Deep access wire bonding to 8mm
  - Fully automated - 8 wire bonds per sec

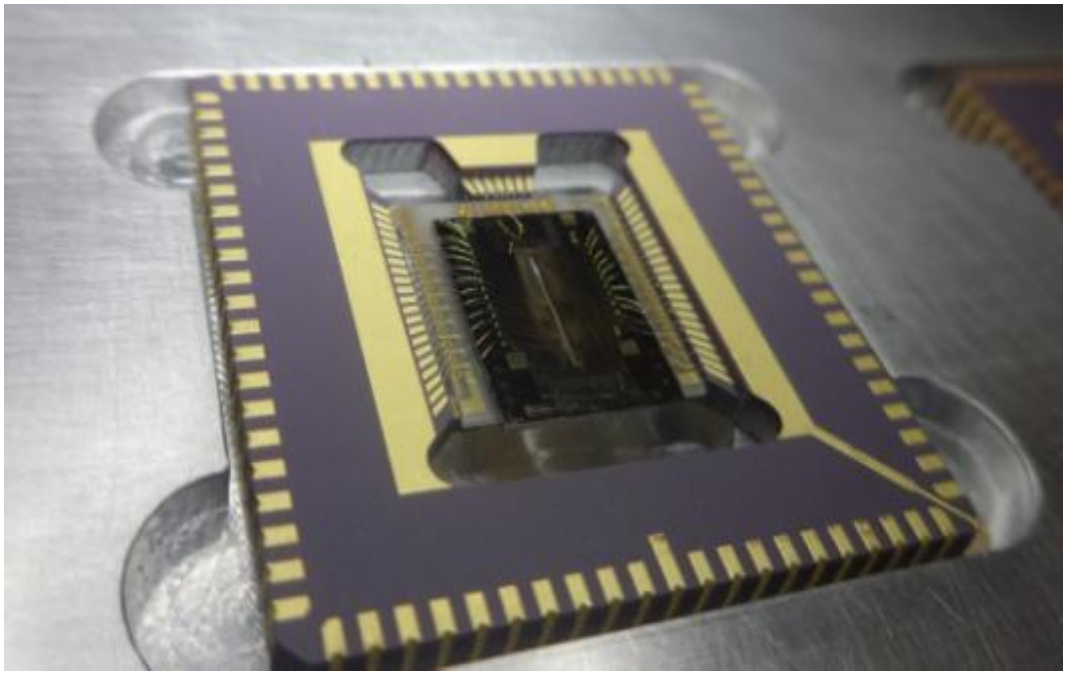


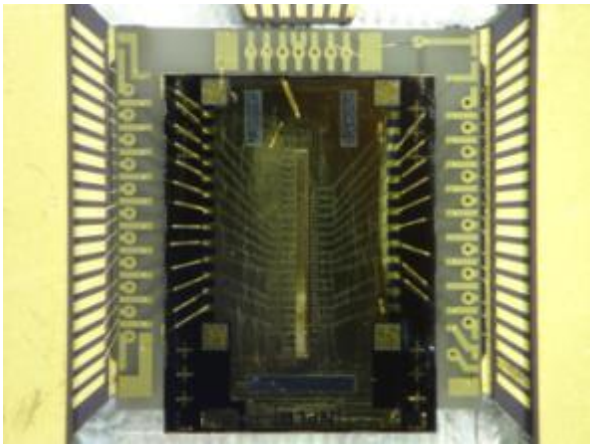
- **Wedge Bonding**
  - Au or Al wire

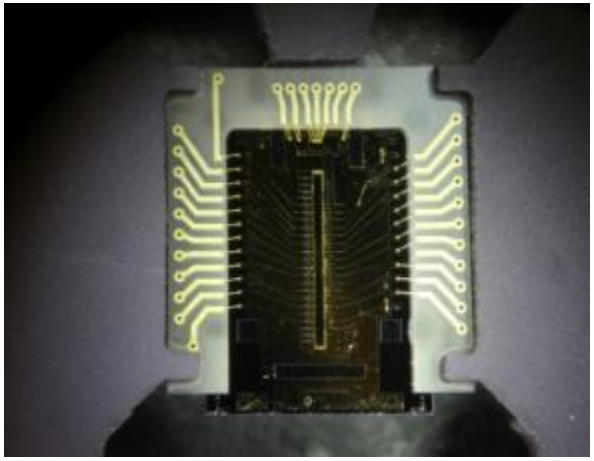


- **Ribbon Bonding**
  - 75um x25um Au ribbon

Assembly – Wire Bonding





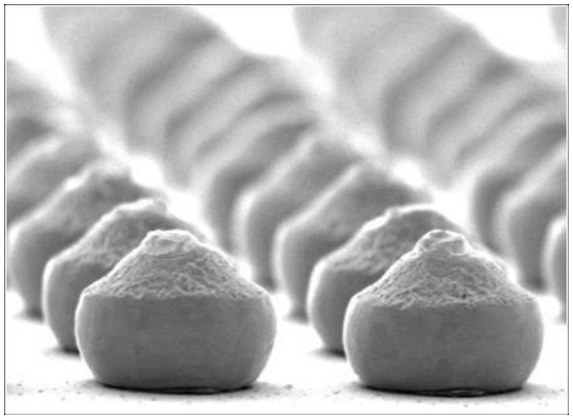


UHV MEMS Package Application
- ion-trap array, Quantum Field Experimentation

Assembly – Bumping and Flip Chip

- Flip Chip and Au stud bumping

- In-House Au Stud bumping capability
  - Bumping can be performed on bare die or wafer scale level
  - Pitch down to 70µm
  - Bump diameters from 50 µm to 90 µm
  - Planarity +/2 µm
  - Wide variety of bump shapes achievable



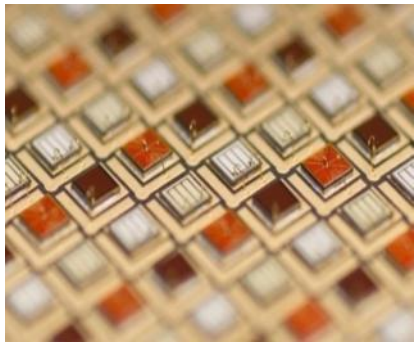
- Flip chip attach
  - Automated and manual processes
  - Thermocompression, Thermosonic and Reflow attach processes

- Typical Materials (other options available on request)
  - Substrate: BT Laminate, Ceramic, FR4, silicon
  - Packages: Customer specified
  - Underfill: Hysol FP4530, FP4511 etc.
  - Bump material; Au stud bumps, Eutectic, High Pb, Pb free
  - Die: Si, GaAs, GaN, SiGe, MEM’s, InP, GaN

Assembly – Encapsulation and Sealing

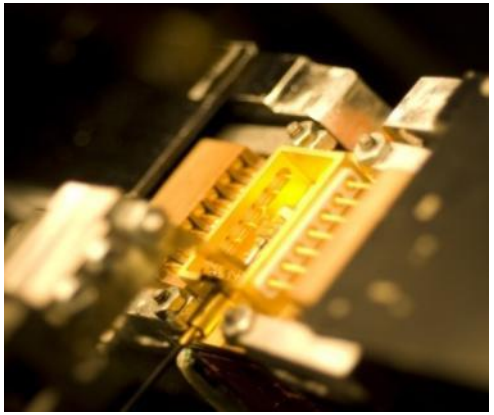
- Glob top and dam and fill
  - Automated epoxy dispense systems
  - Chip on Board Applications

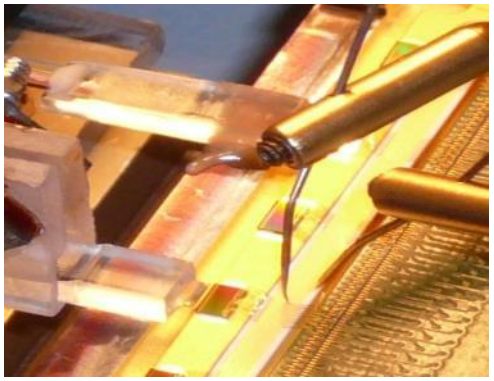
- Seam seal, Solder seal and Projection Weld
  - Ultra low moisture environments <1000ppm
  - Specialist sealing environments He, N, Ar, O_2
  - Fine and Gross leak test to MIL-STD-883, (Space Flight Module Applications)



Assembly – Optical Alignment and Attach

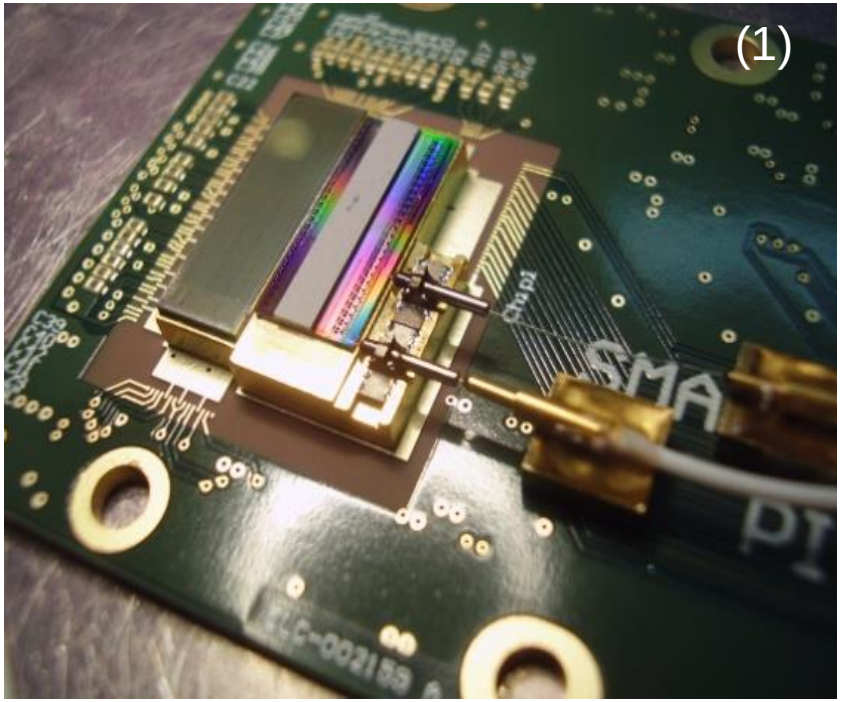
- Lensed SM and PM fibre align and attach using laser weld attach process
- Epoxy attach for multi-mode fibers and Fibre V-groove arrays
- Align and attach capability for free-space optical components such as FAC, SAC, Isolators and Focusing lenses.
- Auto align 3 and 6-axis sub-micron alignment stages
- Test capabilities
  - Optical beam profilers, PER meters, Optical spectrum analysers, LIV Testing
- Applications
  - FAC and SAC lens align and attach to red laser diode in custom TO-header
  - PM Fibre coupled DFB laser with collimating and focusing lenses and optical isolator
  - Integrated miniature optical systems
  - V-groove attach (vertical & horizontal): GC on PIC

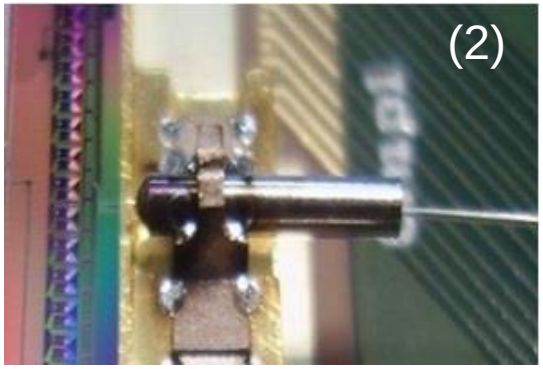


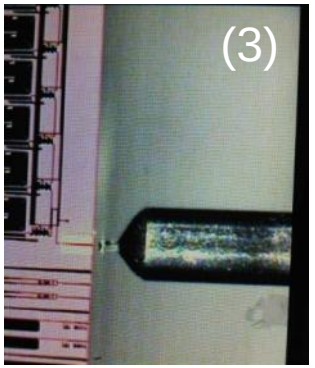


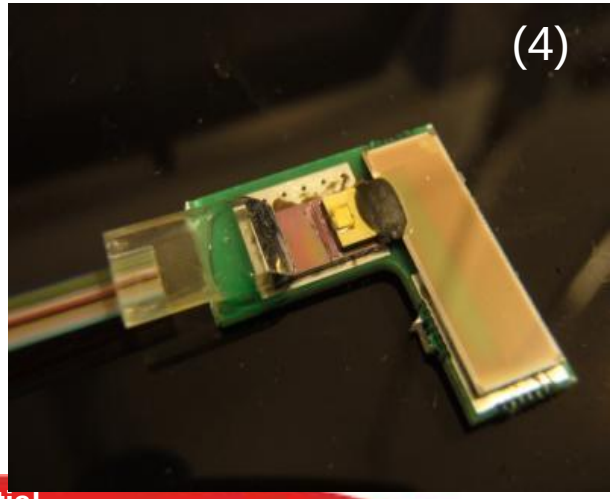
Assembly – Optical Alignment and Attach

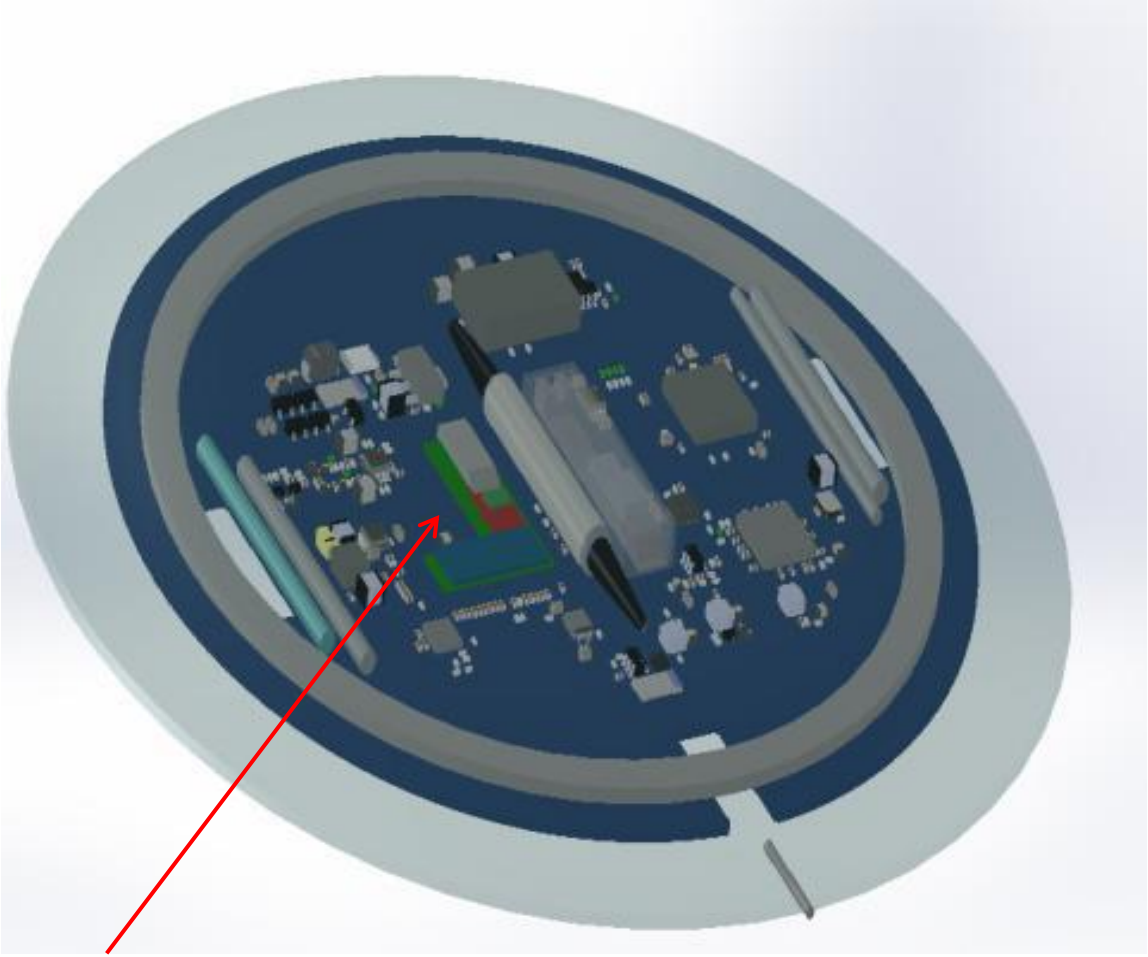
- Example of integrated sub-system (PD-PIC-ROIC)assembly development
- Technology development study to meet environmental and application requirements





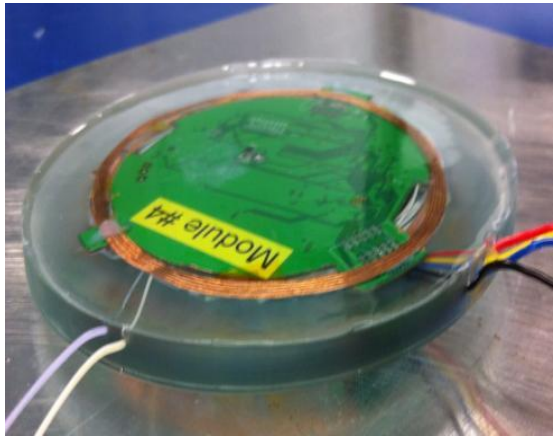






Embedded solution:

- Integrated SLED sub-module
- Improved optical coupling via horizontal fibre v-groove to grating coupler attach



- Company History
  - Markets and Services
- Design & Assembly Capabilities
- **Case Study: Compound Semiconductor Photonic module design & manufacture**

optocap

Case Study:
Integrated Compound Semiconductor Photonic module

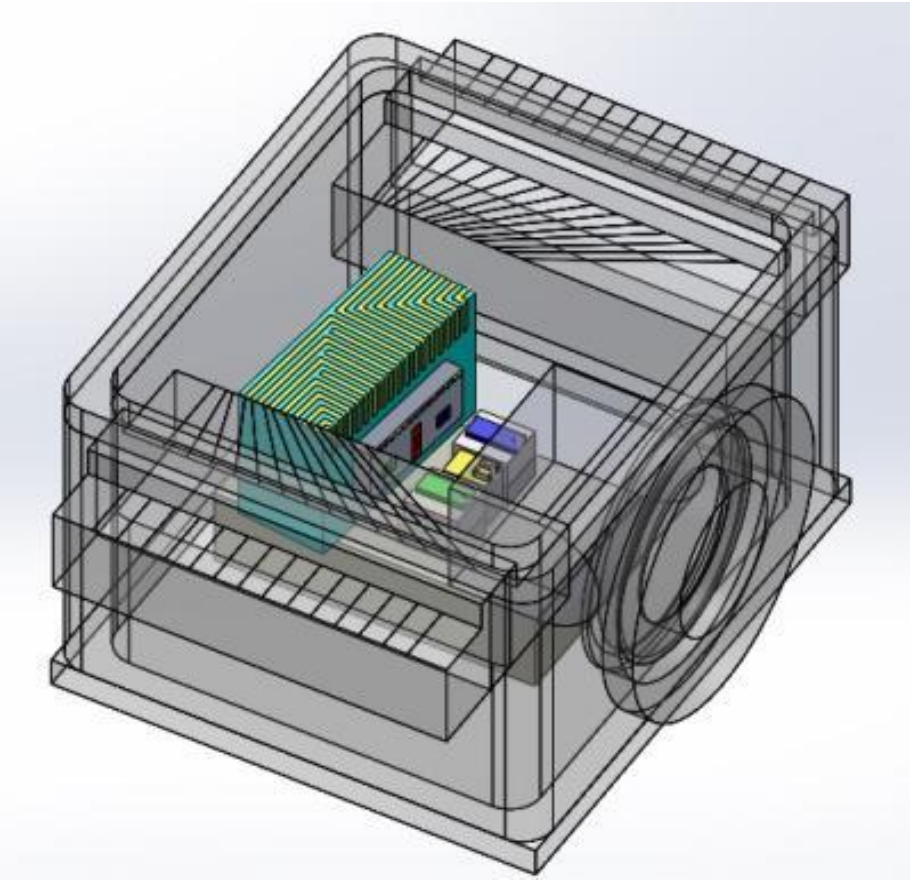
Integrated RGB laser light module for autostereoscopic outdoor displays

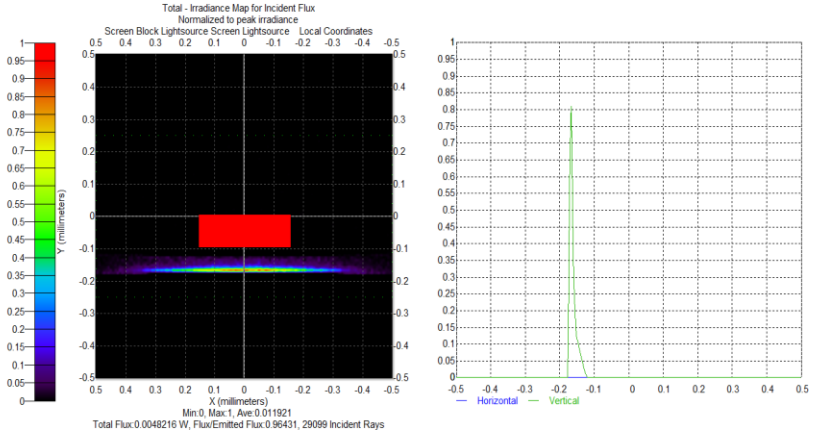
Integrated CS Photonic sub system Case Study

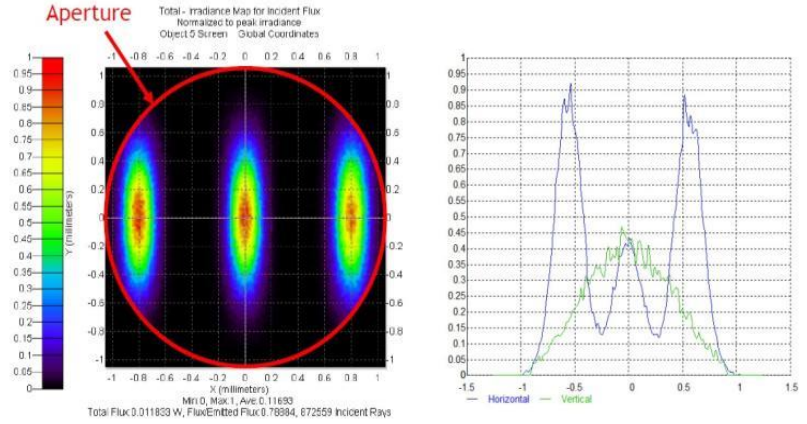
Integrated RGB laser light module for autostereoscopic outdoor displays

- Integrated Optical & microelectronic sub assembly
- Custom design solution for pilot manufacture / proof of principle
- Hermetic Package / controlled internal environment
- Mechanical design:
  - Outer package & sub assembly
  - Process tooling and fixtures
- Optical & Thermal Design & Simulation study
- Process Development:
  - LD placement
  - FAC/SAC Active Alignment

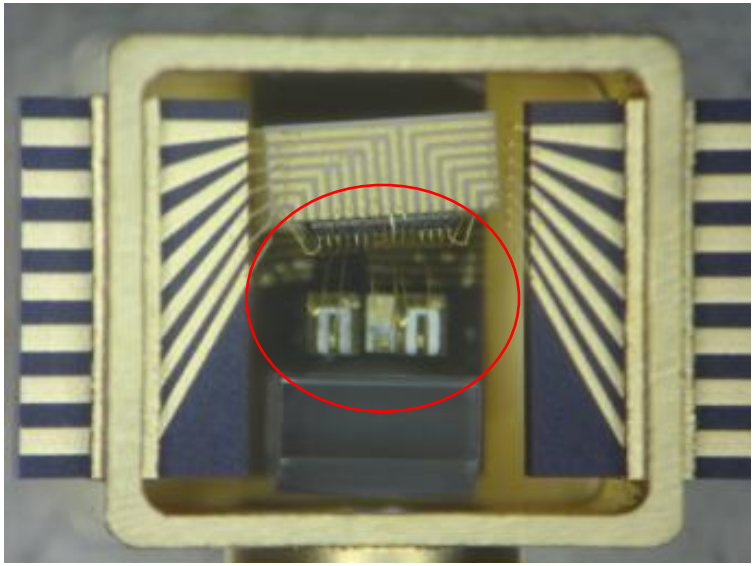
World's smallest RGB Laser Light Source **(SPIE LASE 2015, San Francisco, CA,USA)**



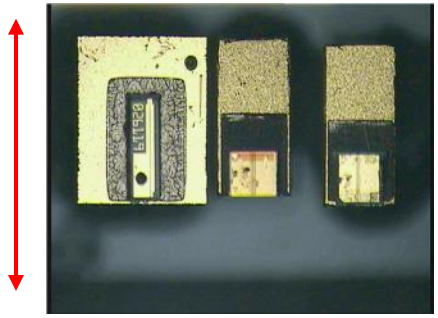




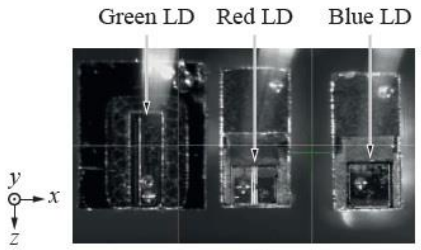
3D CAD model: Mechanical design : optical, thermal simulation



Tolerances, Process / tool design



LD flip-chip attach 3µm accuracy



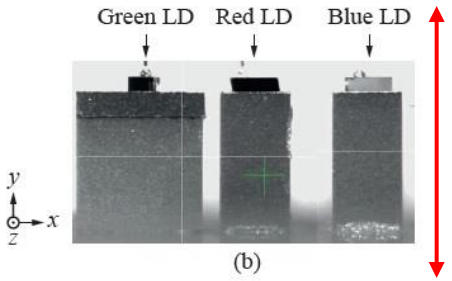


Figure 4. (a) Top and (b) front view of the laser diode subassemblies.

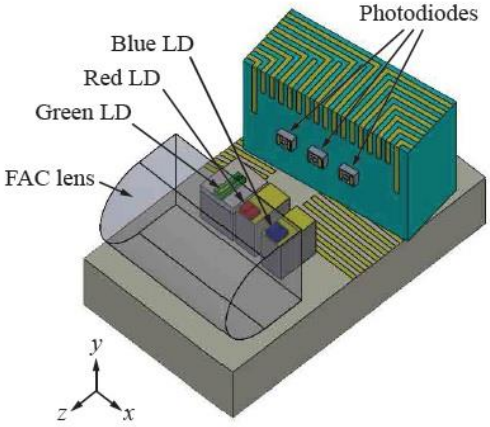


Figure 5. Assembly including FAC lens.

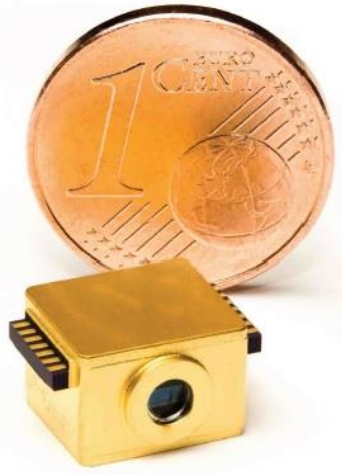
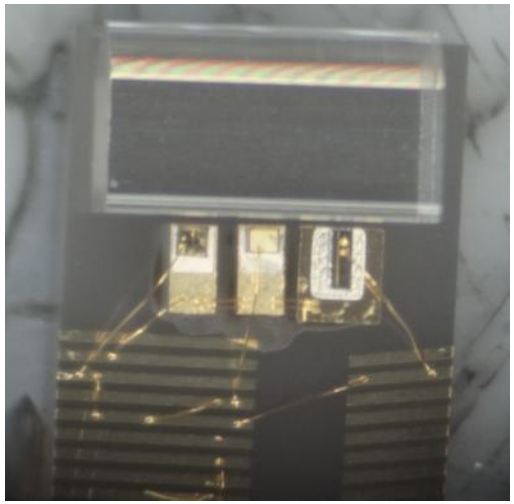
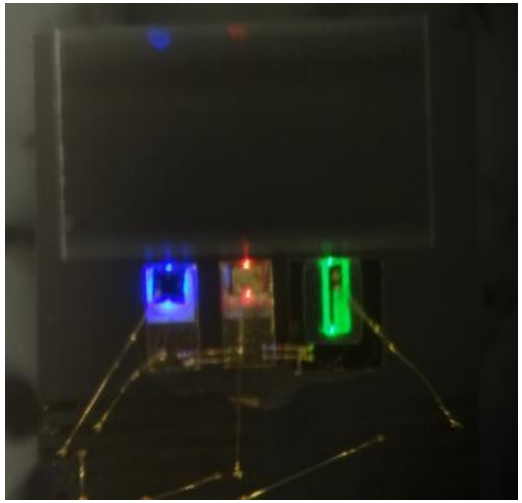
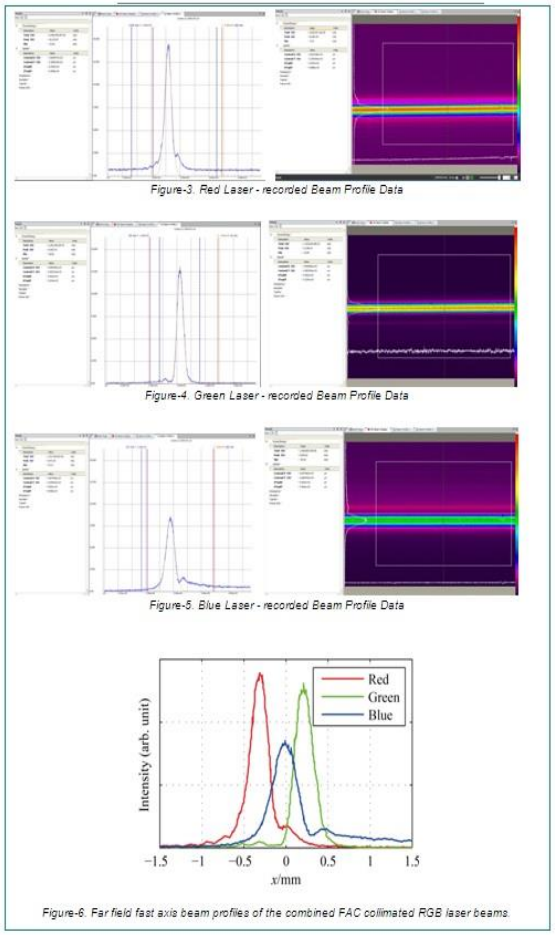


Figure 6. Hermetically sealed package.





Active Alignment of lens
Probes → Probe card



Optical Output

Integrated RGB laser light module for autostereoscopic outdoor displays

Jörg Reitterer[a,b,*], Franz Fidler[a], Christian Hambeck[a], Ferdinand Saint Julien-Wallsee[a], Stephen Najda[b], Piotr Perlin[b], Szymon Stanczyk[b], Robert Czernecki[b], Stewart McDougall[c], Wyn Meredith[c], Garrie Vickers[d], Kennedy Landles[d], Ulrich Schmid[e]

Abstract

We have developed highly compact RGB laser light modules to be used as light sources in multi-view autostereoscopic outdoor displays and projection devices. Each light module consists of an AlGaInP red laser diode, a GaInN blue laser diode, a GaInN green laser diode, as well as a common cylindrical microlens. The plano-convex microlens is a so-called "fast axis collimator" . The three light beams emitted from the red, green, and blue laser diodes are collimated in only one transverse direction, the so-called "fast axis", and in the orthogonal direction, the so-called "slow axis", the beams pass the microlens uncollimated. In the far field of the integrated RGB light module this produces Gaussian beams with a large ellipticity. For this application only very low optical output powers of a few milliwatts per laser diode are required and therefore we have developed tailored low-power laser diode chips with short cavity lengths of 250 µm for red and 300 µm for blue. Our RGB laser light module including the three laser diode chips, associated monitor photodiodes, the common microlens, as well as the hermetically sealed package has a total volume of only 0.45 cm³, which to our knowledge is the smallest RGB laser light source to date.

Applications

MEMS laser scanners for display applications

- Glasses-free 3D outdoor displays[1] (cf. Fig. 1)
- Flying spot pico projectors[2]
- Head-up displays[3]
- Retinal scanning displays[4]

Figure 1. Glasses-free 3D outdoor display for digital signage applications.

RGB laser module components

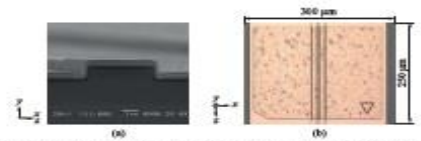


Figure 2. (a) Ridge waveguide cross section and (b) top view of the red laser diode.

Figure 3. LIV curves of the (a) red and (b) blue laser diode.

Optical properties

- RGB beams collimated nearly diffraction-limited
- Divergence angles: Θ'_{red} = 0.49 mrad, Θ'_{green} = 0.62 mrad, Θ'_{blue} = 0.42 mrad
- Beam pointing errors: δ_{red} = -0.62 mrad, δ_{green} = 0.42 mrad

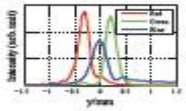


Figure 7. Far field fast axis beam profiles at a propagation distance of 50 cm.

Conclusion

- Smallest RGB laser light source to date
- Development of custom red laser diode, blue laser diode, and FAC microlens
- Total volume of only 0.45 cm³
- RGB laser beams collimated nearly diffraction-limited

System parameters

Microlens

- Custom fast axis collimator[5] (FAC) optimized for RGB wavelenghts
- Beams are collimated only in the „fast axis"
- Narrow stripes in the far field of the light module create 3D effect
- Focal lenghts: f_{red} = 1.203 mm, f_{green} = 1.172 mm, f_{blue} = 1.139 mm

Red laser diode

- AlGaInP on GaAs[6]
- Specifically designed for the application of the 3D laser display
- Short cavity length of 250 µm for low output power and low cost
- λ_{red} = 635 nm

Blue laser diode

- AlGaInN GRINSCH laser diode design[7]
- Specifically designed for the application of the 3D laser display
- Short cavity length of 300 µm for low output power and low cost
- λ_{blue} = 450 nm

Green laser diode

- Commercially available chip
- λ_{green} = 520 nm

Assembly and packaging

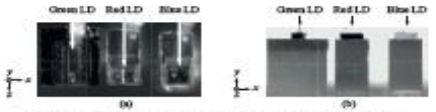


Figure 4. (a) Top and (b) front view of the laser diode subassemblies.

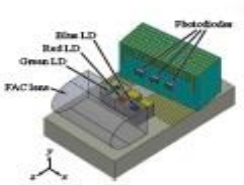


Figure 5. Assembly including FAC lens.

Figure 6. Hermetically sealed package.

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