All-in-glass packaging
for VCELS and other optical systems in harsh environments

EPIC Meeting on New Space at European Space Agency, September 2019

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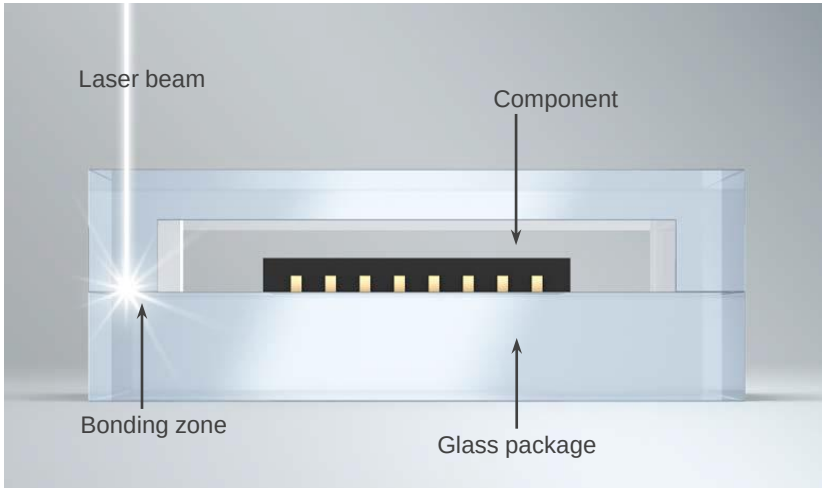
SCHOTT Primoceler Oy: Who are we?

- Glass Micro Bonding specialist founded in 2010 and headquartered in Tampere, Finland
- Joined SCHOTT AG in August 2018
- Pioneering technology: Unique additive-free, room temperature hermetic glass bonding
- Specialized in medical implants, microfluidics, micro-electronics and micro-optics

What is Glass Micro Bonding?

- **Laser-based** hermetic bonding: extremely precise sealing
- **Contactless** method: material surfaces are untouched
- **Minimal heat load**: laser-precision enables a heat-affected zone of just a few micrometers
- **One-step** manufacturing process



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Up to the Challenge: SCHOTT Primoceler™ Glass Micro Bonding is a Proven Superior Alternative to Existing Sealing Methods

	SCHOTT Primoceler™	Anodic bonding	Direct / fusion bonding	Glass frit	Epoxy (UV)	Epoxy (thermal)
Hermetic	**Yes**	Yes	Yes	No / In rare circumstances	No	No
Sealing Process	**No additives**	Silicon or metal needed Glass-glass not possible	No additives	Additives needed	Additives needed	Additives needed
Process temperature	**Room temperature**	440˚C (824˚F)	1000˚C (1832˚F) (no plasma) 440˚C (824˚F) (with plasma)	440˚C (824˚F)	Room temperature	200˚C (392˚F)
Clean room class requirement	**100 / 1000**	100	10	1000	1000	1000
Surface quality required (Ra)	**< 10 nm**	< 2 nm	< 0.5 nm (no plasma) <2 nm (with plasma)	< 1 um	< 1 um	< 1 um

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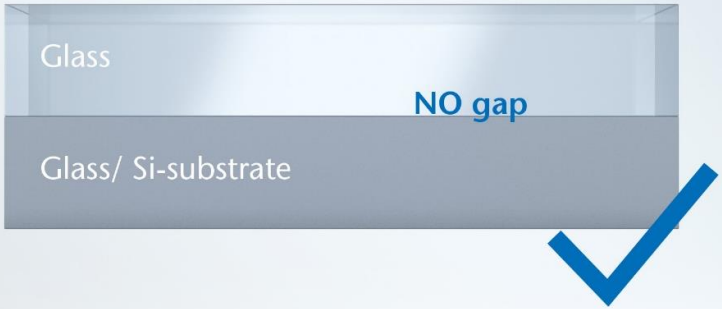
Gap Control and Additive-Free Technology Enables Higher Reliability for Micro-Optic Applications

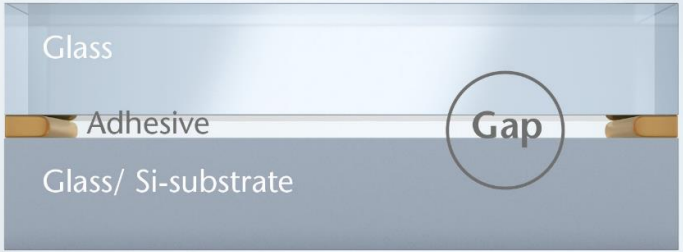
SCHOTT Primoceler Glass Micro Bonding

✓ Direct bonding without additive materials
✓ No gap between top and bottom substrates



Other Bonding Methods

- Additive materials used for bonding
- Gap between top and bottom substrates
- Controlling the gap is difficult or impossible



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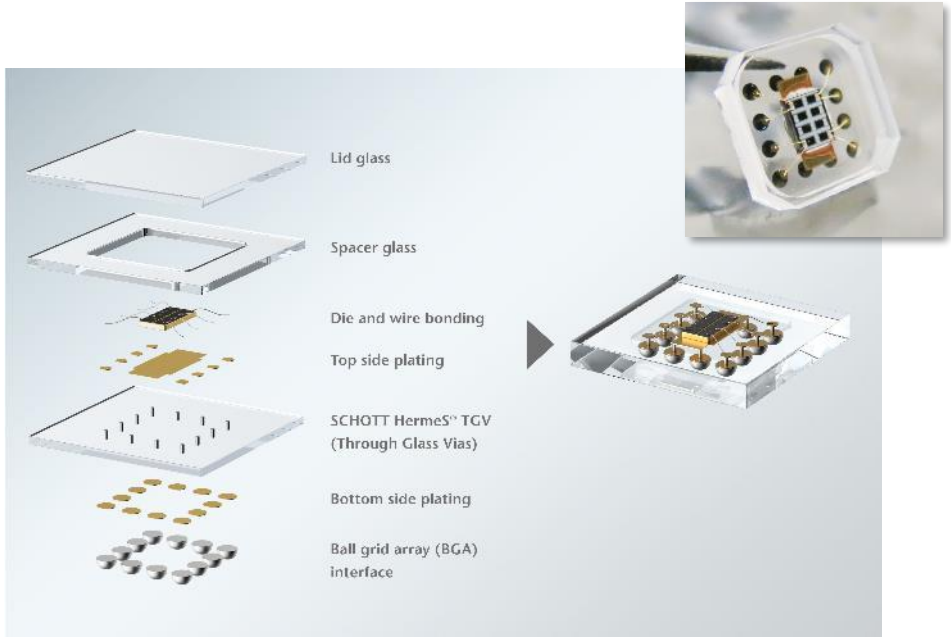
Project with the European Space Agency (ESA)
Hermetic and Radiation Tolerant Glass Package for VCSELs

- Various glass materials available
- Package solution consists of hermetic Through-Glass-Vias (TGV) and a standard BGA balling
- Challenging the technique by using radiation hard glass, BK7G18



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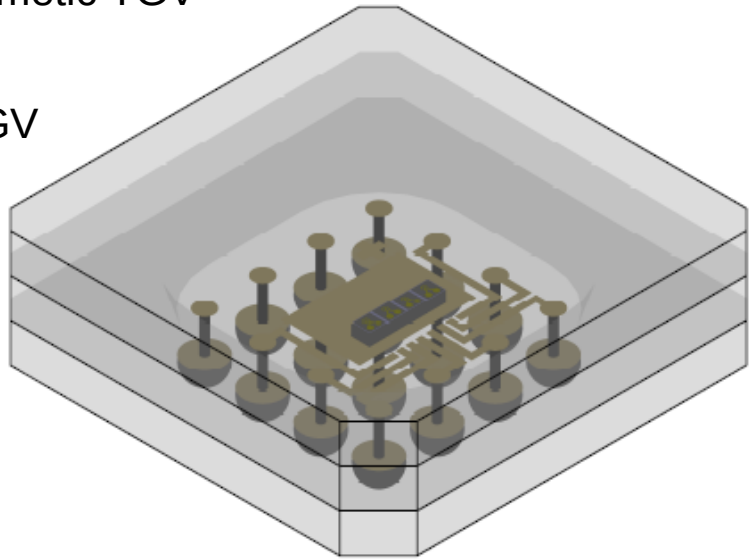
Design result - all-in-glass rad hard package

- Commercially available VCSEL, glass and hermetic TGV
- New glass and via material combination for TGV
- BK7G18 with FeNi42 vias
- Package size 1,5mm x 1,5mm x 0,5mm
- 3-layer structure, BGA



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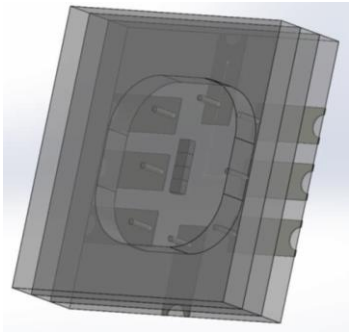
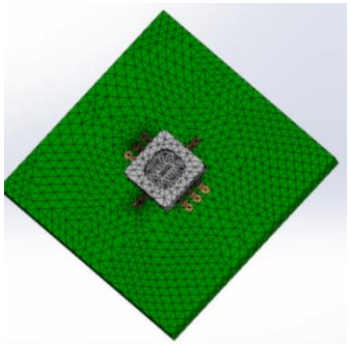
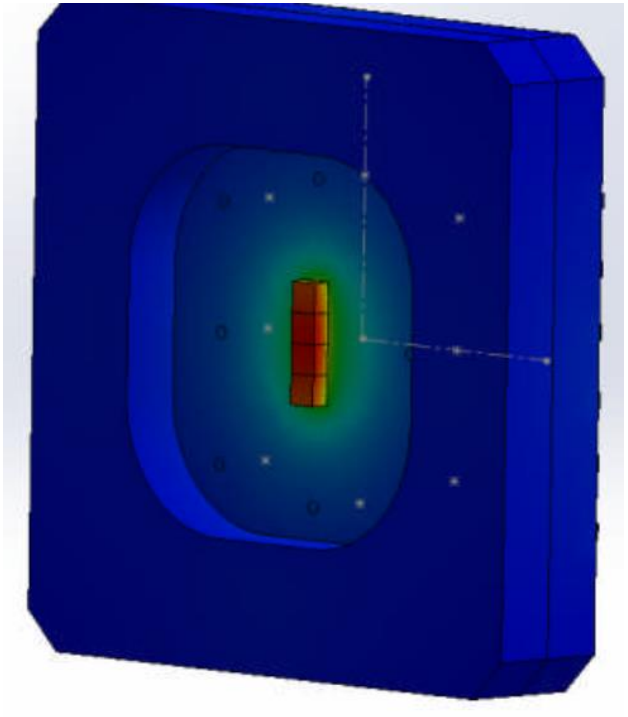
Evaluating thermal performance – Thermal modelling

Assumptions:

- Operating range 5…45°C
- Power dissipation 20mW for all devices
- No forced cooling
- Worst case scenario







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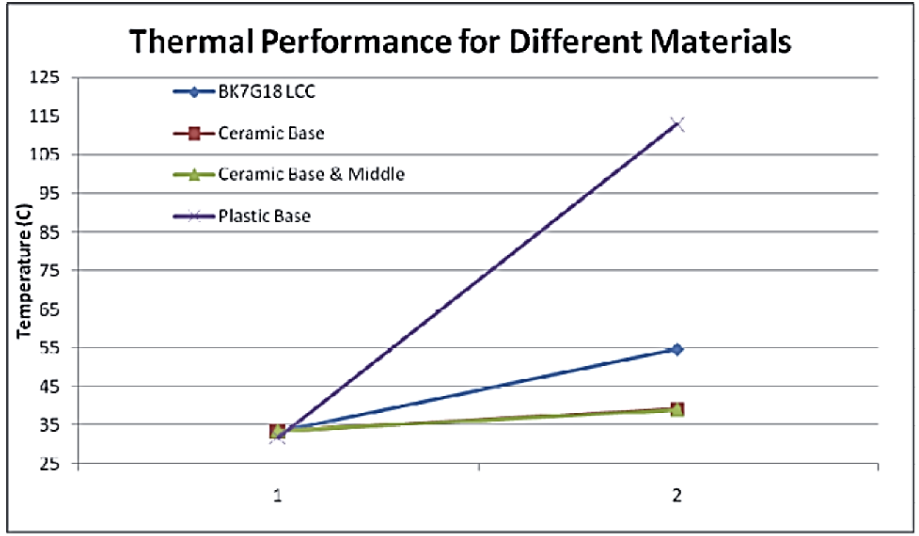
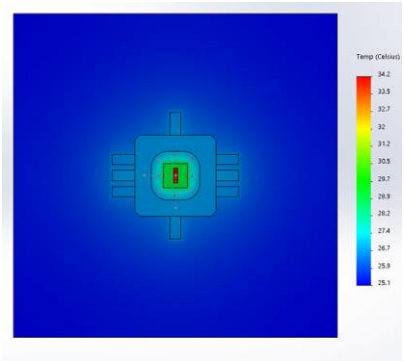
Evaluating thermal performance - comparison to other materials

Thermal performance of the package can be easily further improved, for example by:

- Attaching the LGP to a PCB ➔ 46ºC
- Including metallized pad on both PCB and LGP ➔ 43ºC
- Higher dimension thermal TGV pad below the VCSEL





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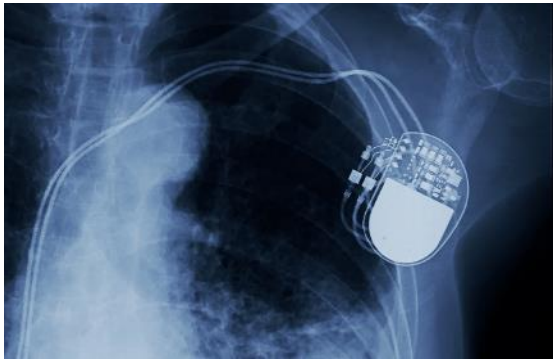
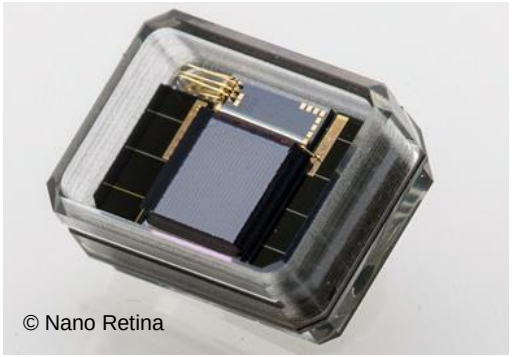
Full-glass packages enable next generation active medical implants



RF Transparency

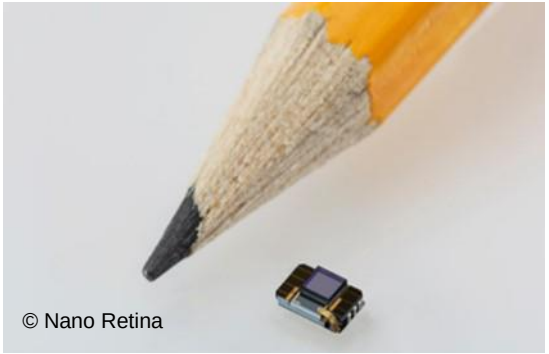
- Wireless power and data transfer



Biocompatibility*

- No additives or adhesives
- High hermeticity

"biocompatible according to ISO 10993-4 and 10993-5 (non-Hemolytic, non-Cytotoxic)



Room Temperature Process

- Flexible assembly sequence
- Die and wafer level possibility
- Suitable for many coatings and sensitive components

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Unmatched Miniaturization: SCHOTT Primoceler™ all-glass packages come in sizes so small, you have to see it to believe it

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Questions?

Full visual inspection can be done with microscopes

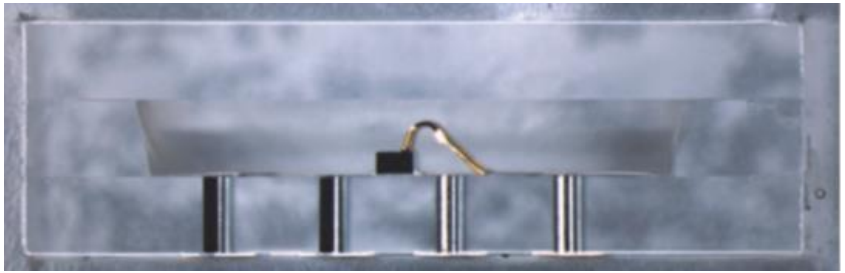
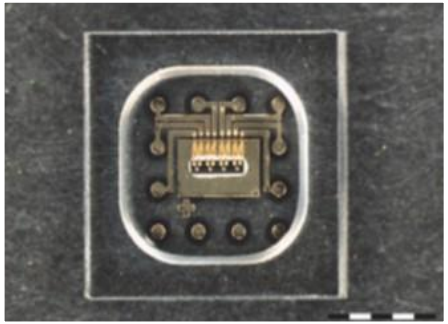
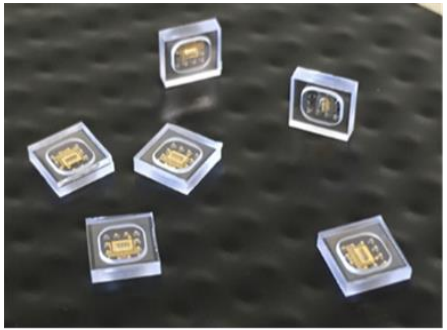


Figure: Cross-sectional image of the package.

Figure: Pre- and post-stress optical pictures.



Figures: Diced devices



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