IEEE EST EPS Electronics System-Integration Technology Conference

Development of a platform for functional glass packages for the integration of micro-optical and -mechanical systems on wafer level

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I. Motivation & Goal

- Optics play a major role in technical systems:
  - Object recognition e.g. in autonomous driving.
  - Projection -> modulated light and AR/VR applications
- Low priced, robust and hermetic housing techniques are needed
- Goal: Extension of hermetic packaging to wafer level with optical functionality

II. Micromirror glass housing concept with electrical feedthroughs

- SMD-capable structure: electrical contacting through silicon feedthroughs
- Solder connection MEMS to substrate: low stress transfer to the component
- complete protection of the MEMS and the electrical contacts by a housing
- Defined atmosphere and getter
- Reflection avoiding in projection due to glass dome housing
- Large deflection of the mirrors possible at low drive voltages

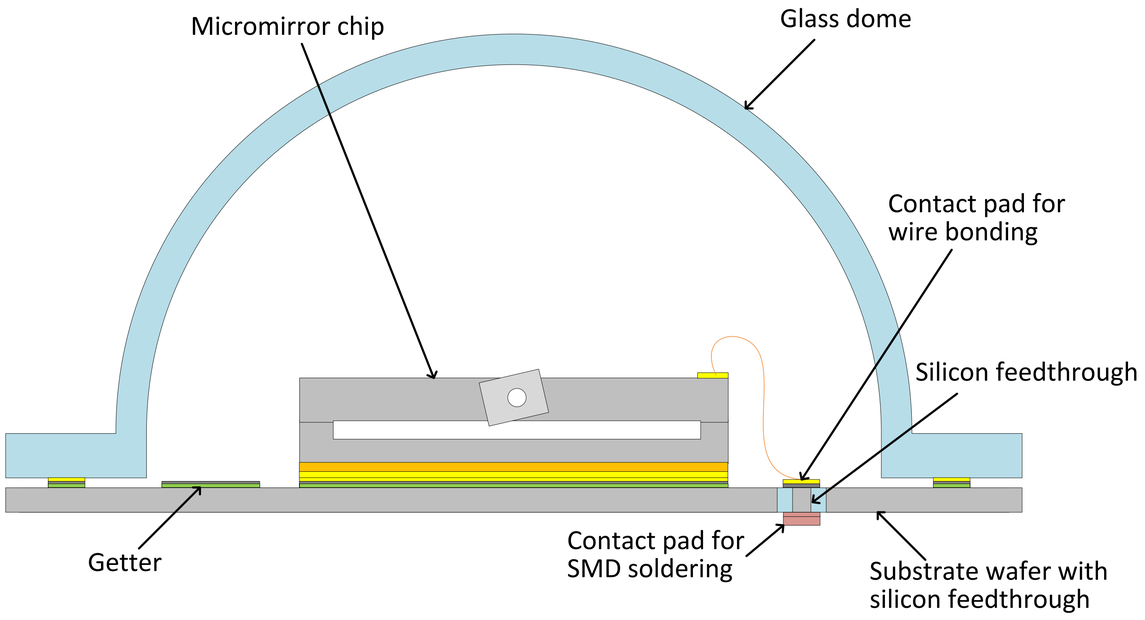

Fig. 1: Housing concept of a laser-soldered micromirror concept in a hermetic glass dome housing.

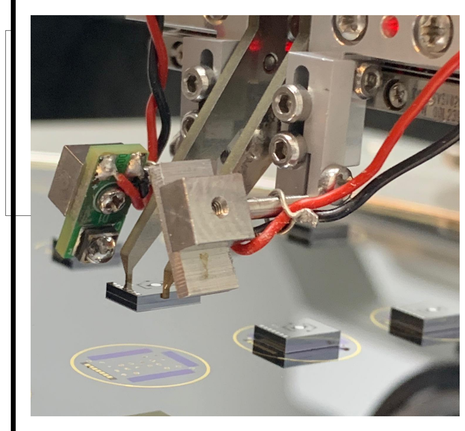

Fig. 2: Assembly and soldering of the micromirrors

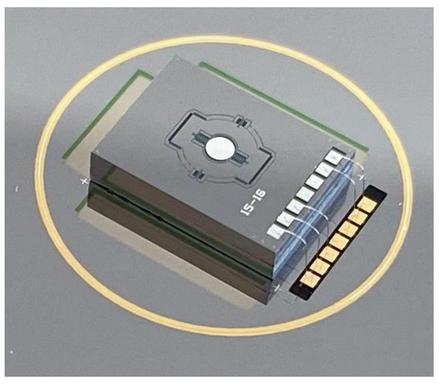

Fig. 3: Electrical contacting by wire bonds.

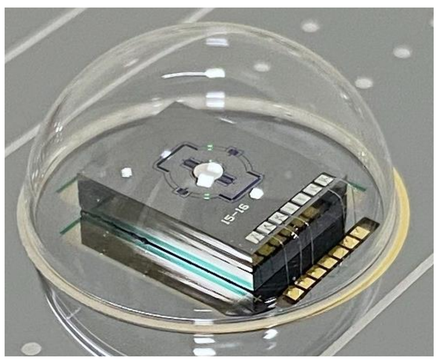

Fig. 4: Hermetic capping with a glass dome housing with getter.

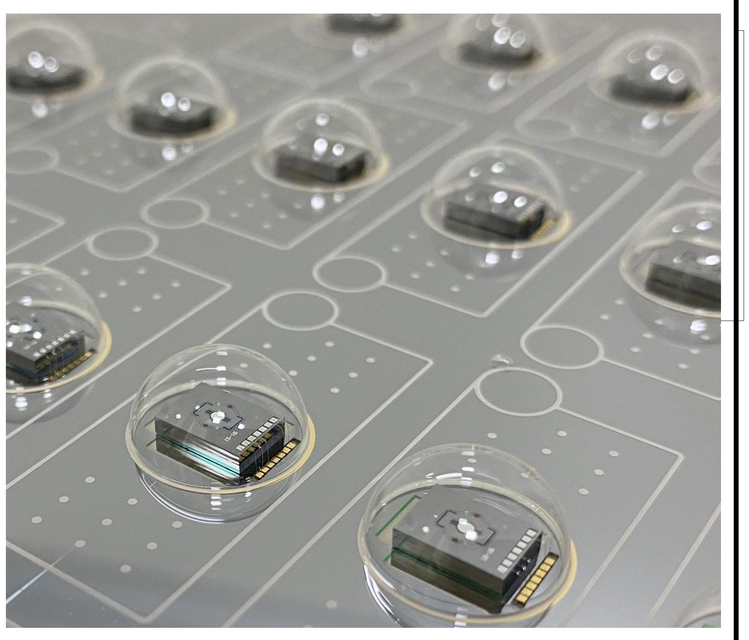

Fig. 5: Completely assembled 8" wafer. Capping at wafer level.

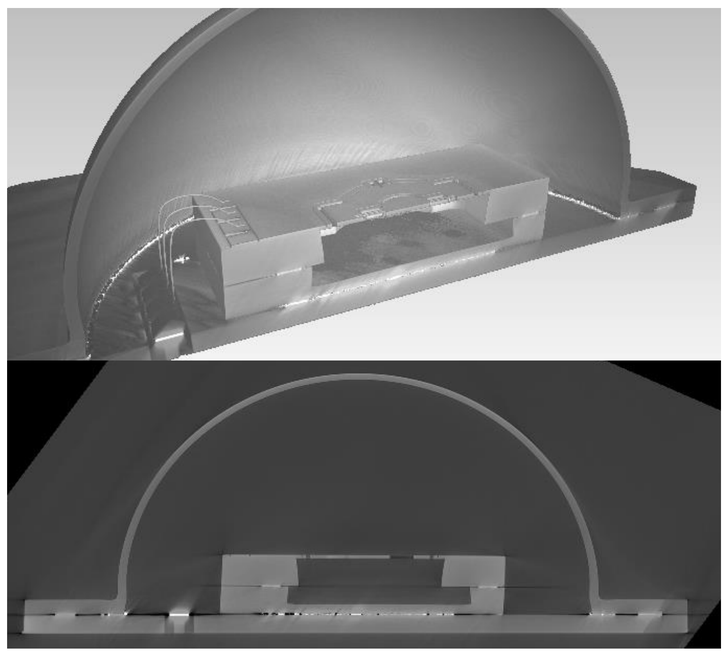

Fig. 6: X-ray image of a micromirror chip

III. Design concept for a miniaturized laser source based on silicon substrates

- A glass-silicon platform enables hermetic housing of laser diodes in a defined atmosphere
- A 3D-molded glass cap with a very thin exit window enables lateral beam decoupling
- Lateral beam guidance enables beam combination with commercial optics and active alignment

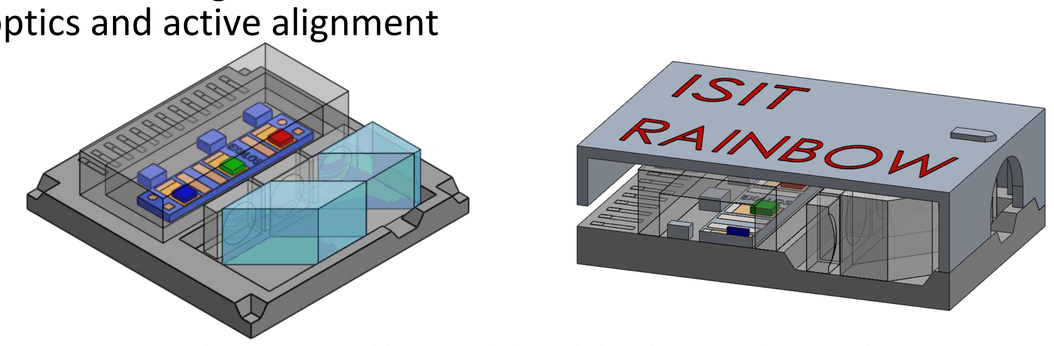

Fig. 7: Construction of a miniaturized laser module with free beam guidance and power monitoring. The glass cap with very thin exit window allows lateral beam decoupling. The size is 6.8mm x 7mm x 2.9mm (IP US 10,283,930 B2).

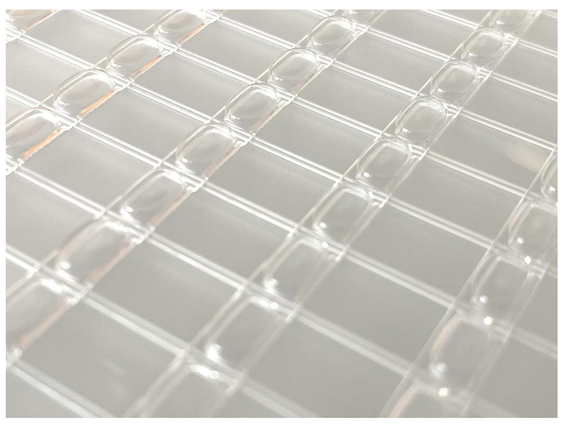

Fig. 8: Section of the glass housing from an 8" wafer. The window thickness is 160µm with 725µm inner height.

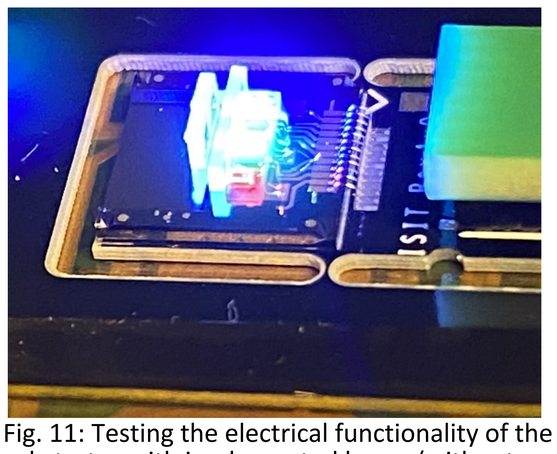

Fig. 11: Testing the electrical functionality of the substrates with implemented lasers (without glass cap).

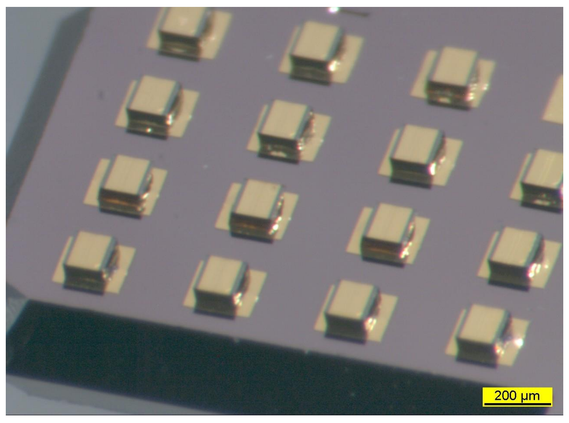

Fig. 9: Laser direct soldering of laser diodes

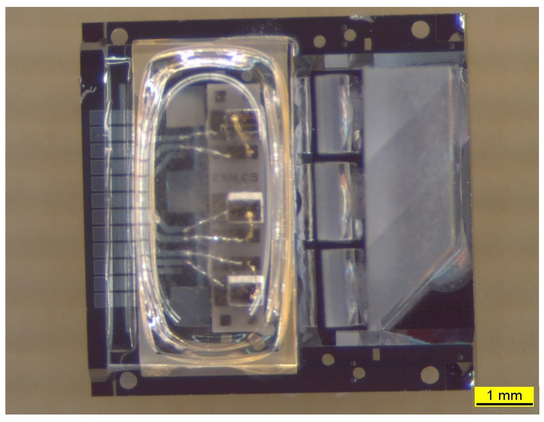

Fig. 12: Completely loaded substrate with glass cap (top view, top)

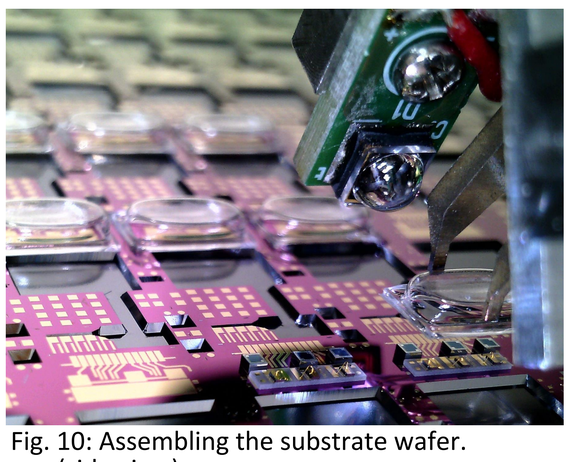

Fig. 10: Assembling the substrate wafer. cap (side view)

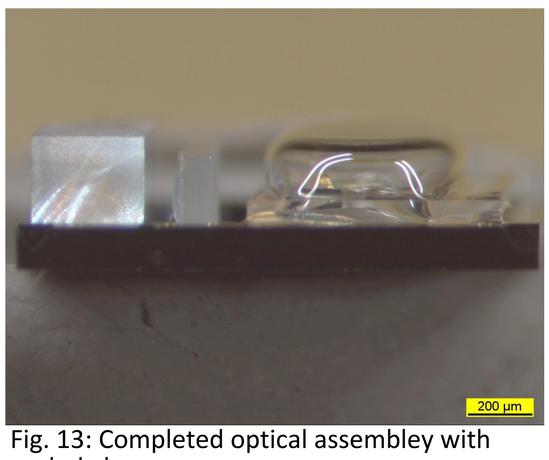

Fig. 13: Completed optical assembley with sealed glass

IV. Outlook

- The performance of the glass technology kit was confirmed by two demonstrators
- Automatic assembly and laser soldering still need to be further developed
- The focus is currently on the development of a low-temperature bonding technology with metal pastes or multilayer metals

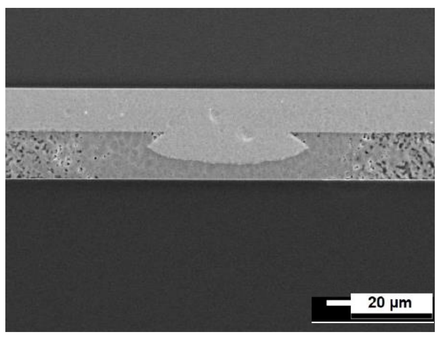

Fig. 14: Cross section of a low-temperature joint

V. Acknowledgment

We greatly acknowledge the financial support by the Federal Ministry of Education and Research (BMBF 13N12426, 16ES0729, 16FMD02 and 16FMD01K) to develop specific parts of the modular Glass-Silicon packaging platform.