EFFICIENT FIBER-PHOTONIC INTEGRATED CIRCUIT CONNECTION VIA WAFER-SCALE GLASS MOLDING

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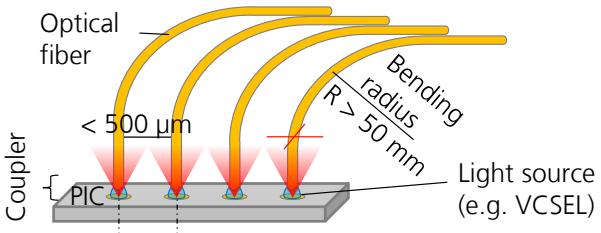
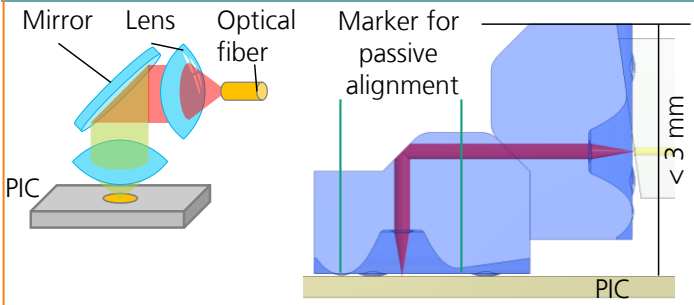
Shortened Abstract: Increasing demand for higher data rates in data centers is driving efforts to produce single-mode optics, which substantially improves the commonly used infrastructures. However, the fiber coupling to photonic integrated circuits (PICs) is currently a bottle neck. The optics needed to link optical fibers to PICs are sub-millimeter in size and call for extreme precision both at the manufacturing as well as the assembling stage. Using glass instead of plastic optics in-creases the optical performance and therefore, the transmissible data rates but results in higher production costs.
Fraunhofer IPT and partners developed an innovative, efficient glass fiber coupling technology based on the replicative process of glass molding. To fabricate the fiber couplers, two different glass molding technologies were explored and compared: The highly precise, but slow isothermal process of precision glass molding (PGM) and the more efficient, but less precise non-isothermal glass molding (NGM). A scale-up strategy has been developed which is based on a wafer-scale approach.

#1 – Background and initial situation



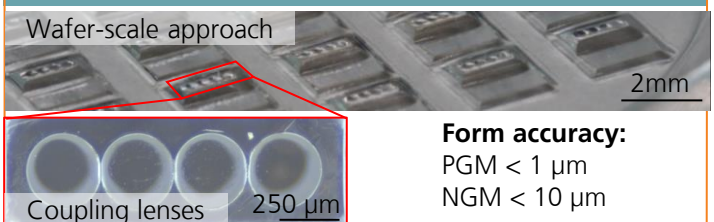
Typically, single mode fibers are coupled vertically to the PIC plane. Due to the min. bending radius, large amount of construction space is needed. Also cost-intensive active alignment for fiber-to-chip coupling is needed.

#2 – New approach



Fiber coupling shall be realized by using molded glass-optical systems. This allows 90°-beam deflection (reducing construction space) and passive alignment (cost reduction)

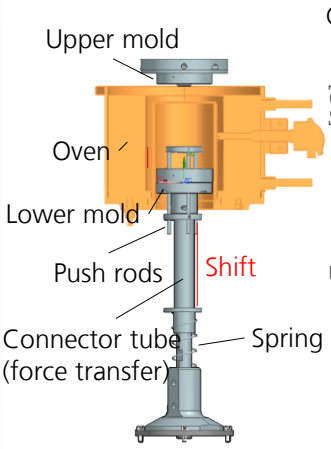
#3 – Glass Molding

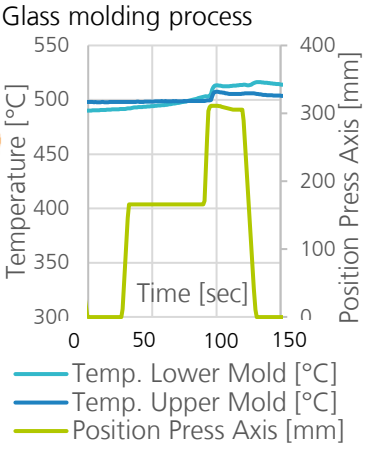


Form accuracy:
PGM < 1 µm
NGM < 10 µm

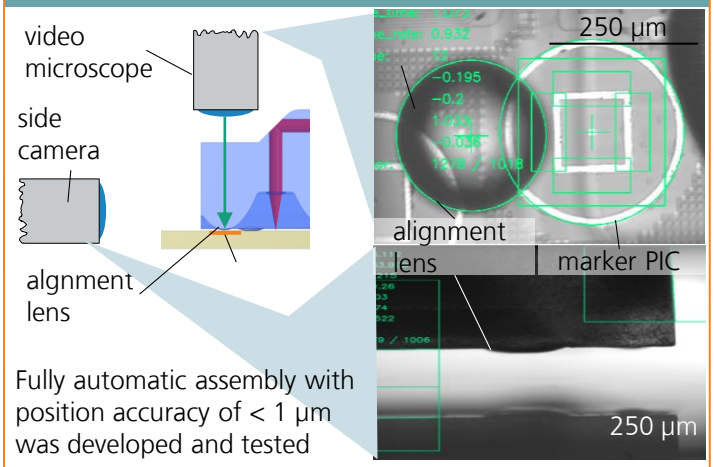
Besides the conventional PGM, a non-isothermal glass molding process was developed at IPT, whcih is less precise, but allows lower production costs and higher production volume (10x shorter cycle time). Glass molding was conducted on wafer-scale.

#4 – Novel NGM approach





#5 – Micro-assembly



Fully automatic assembly with position accuracy of < 1 µm was developed and tested

#6 – Conclusion

A method and production technology for cost-and transmission-efficient and realization of single-mode fiber coupling to PIC has been successfully developed. Functional field test show a insertion loss of < 3 dB