On-chip MEMS for photonic alignment

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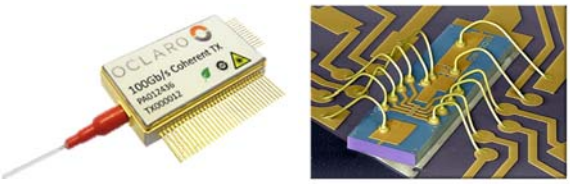
Motivation

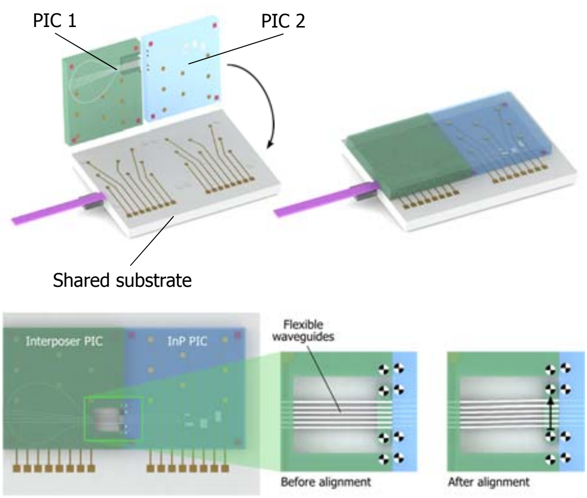
New generations of Photonic Integrated Circuits (PICs) provide complex functionality and can be fabricated at acceptable cost levels. They are used in advanced modules for e.g. data communication. The packaging (the integration and interconnection of all components in a housing) typically represents a large fraction of the production costs and assembly methods offering lower cost would accordingly offer a major advantage in the industry. In particular the high-precision required in component alignment (±0.1µm) is a challenge.



Example photonic package: 100Gb transmitter package (left) tunable laser chip (right) - images courtesy Oclaro

Concept: on-chip “assembly machines”

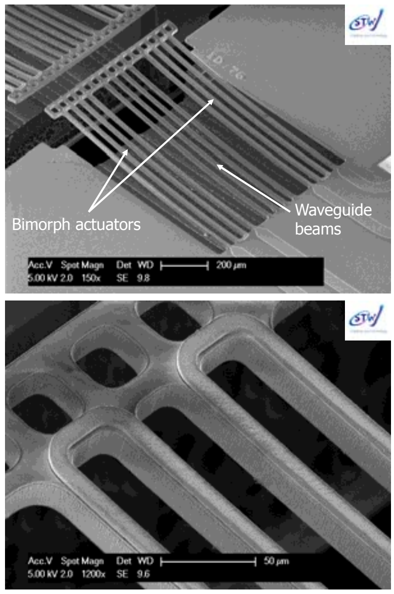
We aim to implement a concept which allows for assembly and alignment of two photonic chips with increased levels of automation, higher yield, and lower cost. The concept exploits MicroElectroMechanical System technology (MEMS). A two-stage assembly process is used. Advanced pick-and-place machines flip-chip bond the photonic chips onto a common substrate. Precision levels are typically in the order of a few µm. Next, MEMS functions integrated with one of the chips take care of fine alignment, and target at ±0.1µm precision for each of the individual waveguides.



Package concept (top), flexible waveguide alignment concept (bottom)

Design and fabrication

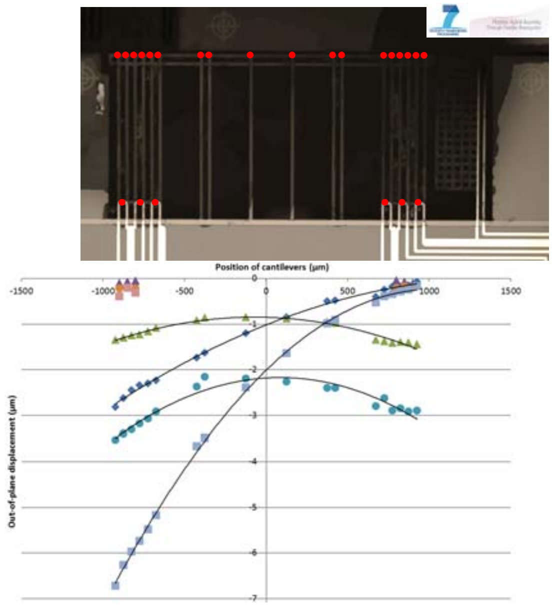
Within the TriPleX^{TM} material platform (SiO_2 – cladding with Si_3N_4 waveguide cores) waveguide beams and actuators are released by micro-fabrication. This leads to mechanically flexible waveguide beam structures. Thermal bimorph actuators are used to deform this structure and to fine-align the waveguide end-facets.



SEM pictures of released waveguide structures with thermal bimorph actuators

Results

Series of waveguide structures and actuators were successfully fabricated. Depending on the design, a fine-adjustment range of several micrometres can be achieved.



Acknowledgements

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