Optical 8-Channel, 10 Gb/s MT Pluggable Connector Alignment Technology for precision coupling of laser and photodiode arrays to polymer waveguide arrays for Optical Board-to-Board Interconnects

Part of the IeMRC OPCB Flagship Project

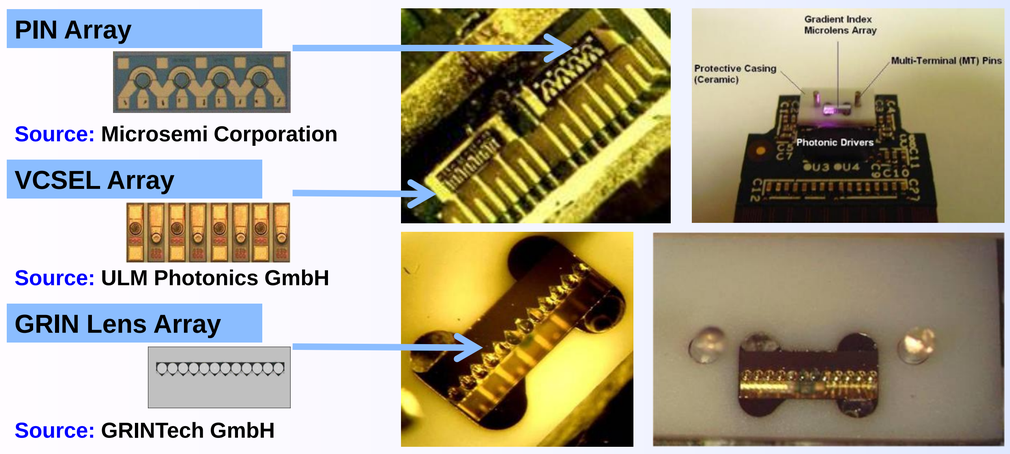
Kai Wang, David R. Selviah, Ioannis Papakonstantinou and F. Anibal Fernández
Department of Electronic & Electrical Engineering, University College London, Torrington Place, London WC1E 7JE
Richard A. Pitwon, Ken Hopkins and Dave Milward Xyratex Technology Ltd.
Email: d.selviah@ee.ucl.ac.uk Phone: +44 20 7679 4157

Introduction

Optical interconnections are being investigated for short distance data communication applications on printed circuit boards (PCB) to replace copper tracks which suffer severe cross-talk as data rates rise above 10 Gb/s, increased loss and cost. Optical beams can pass through one another in free space without any cross-talk so offer an attractive alternative provided the cost of the optical interconnections can be minimized. Polymer multimode waveguides on printed circuit boards provide low cost 10 Gb/s communications overcoming cross talk, loss, and distortion inherent in copper tracks, [1]-[2]

University College London (UCL) is technical leader of the whole project. We work closely with all the partners in the consortium and are responsible for

- Design the layout of the waveguide patterns
- Modelling and Characterisation
  - Computer modelling of waveguide components
  - Compare the modelled results with the experimental results
- Derive design rules for optical PCB
- Design commercially realisable connectors
  - Determine misalignment tolerances

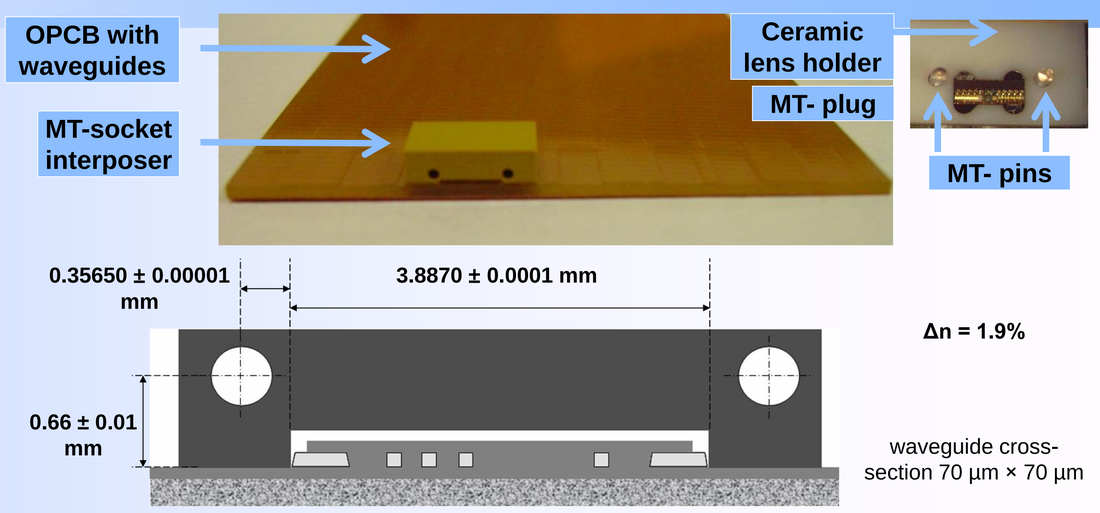


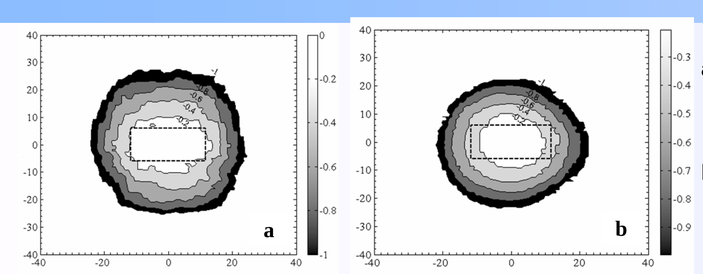
Photonic interface design

- An array of four 10 Gb/s Vertical Cavity Surface Emitting Lasers (VCSELs) and an array of four 12 GHz PIN photodiodes (PDs) were mounted within the MT plug assembly.
- An array of graded index (GRIN) lenses imaged the VCSEL output onto the waveguides and the waveguide output onto the PDs, and protected the VCSEL and PD bond wires and faces.

Commercially realisable connector design

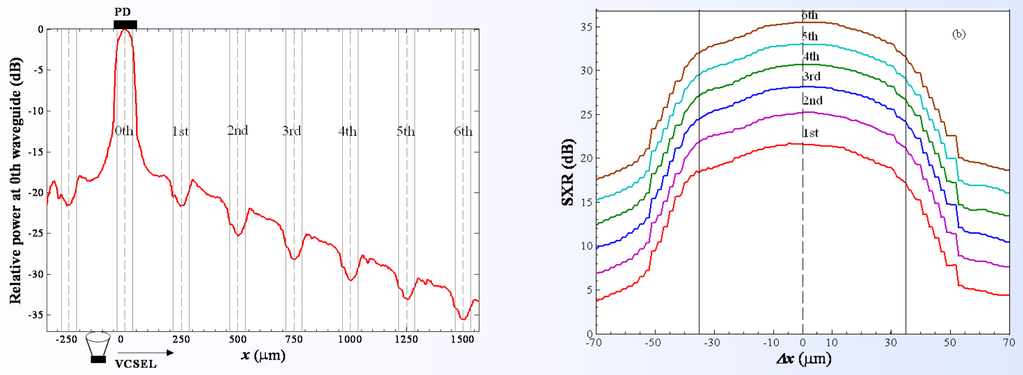
- The waveguides were fabricated photolithographically
  - Passively aligned accurately to the MT-holes of the socket by means of mechanical registration features, fabricated at the same time, by the same e-beam mask and in the same material as the waveguide cores.
  - The aggregated tolerance was ± 6 μm for in plane and out of plane alignment and 10 μm in the axial direction
- The alignment of the socket alone was ± 3 μm in plane and ± 4 μm out of plane





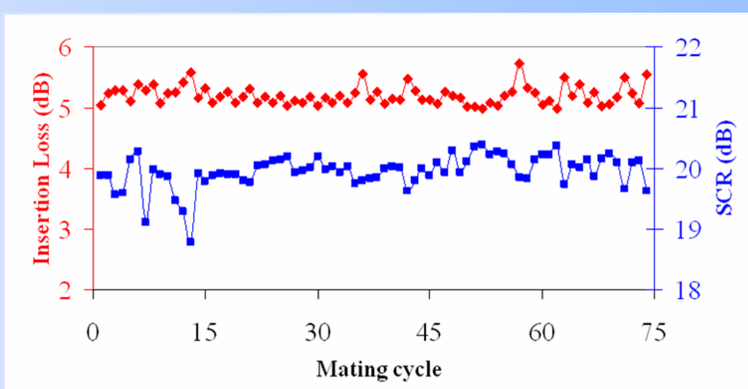
a) Contour map of relative insertion loss compared to the maximum coupling position for VCSEL misalignment at z = 0.
b) Same for PD misalignment at *z* = 0. Resolution step was *Δx* = *Δy* = 1 μm

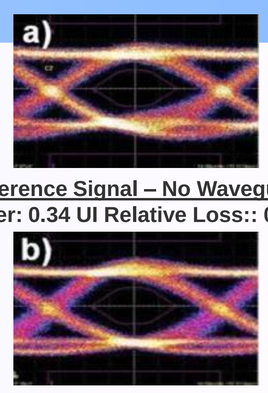
Measurement



- At the worst alignment position, our connector contributes only an extra 0.2 dB of loss due to the VCSEL misalignment and only 0.4 dB of extra loss due to the PD misalignment.
- The cross-talk between adjacent waveguides was -20 dB.
- We report, the first measurements, to our knowledge, of cross-talk as a function of lateral misalignment of the VCSEL array.

- The reproducibility of the insertion loss and the variability was 0.16 dBm
- Clear eye-diagrams at 10 Gb/s with jitter < 38 ps





Reference Signal – No Waveguide
Jitter: 0.34 UI Relative Loss:: 0 dB

10 cm Waveguide with index matching fluid
Jitter: 0.36 UI Relative Loss:: 4.5 dB

Summery

- A passive, precision, self-alignment technique is reported
- A prototype multiple channel duplex connector using this approach was designed, constructed and tested.
- We are exploring variety of polymer waveguides manufacture techniques

References, acknowledgement and funding

[1] A. Deutsch, Proc. IEEE, vol. 86, pp. 315–357, 1998.
[2] H. Cho, P. Kapur, and K. C. Saraswat, J. Lightw. Technol.. vol.22, pp.2021-2033, 2004.
The authors thanks Frank Tooley in Photonix Ltd and Navin Suyal in Exxelis