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Spotlight on "Accurate interchannel pitch control in graded index circular-core polymer parallel optical waveguide using the Mosquito method"

Published in Optics Express, Vol. 22, Issue 7, pp. 8426-8437 (2014)

http://proxy.osapublishing.org/spotlight/summary.cfm?id=282448

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Spotlight summary:

The successful story of fiber-optics has demonstrated the superiority of optical communications over competitor technologies in long-haul data transmissions. Now, short-range high-capacity data interconnects is envisioned as the next field where optics and photonics technologies are likely to play a revolutionary role. In this contest, energy consumption per bit is the key number, and photon transmission is potentially much less power hungry than electronic transmission. This is the reason why, in a near future, massive data exchanges between and inside supercomputers are expected to be carried by photons.

A part of this new story has already become reality. Board-to-board interconnects in supercomputers is already performed though multimode fiber links, providing high-bandwidth-density wirings with lower power consumption than that required by electric cables. But we can definitely do more; we can try to bring photons closer and closer to the brain of supercomputers. The new frontier is chip-to-chip optical interconnects, that is photonics links providing high-capacity and energy saving communications between electronic chips. Although this research field has been under the lens for several years, a winner photonic technology has not emerged yet. And the race is getting faster and faster.

Silicon photonics is considered one of the most promising technology candidates, because it enables the integration of fast modulators, wide-band routing and switching architectures, and photodetectors onto the same chip. In other words, all we need for realizing end-to-end optical links on a chip. Yet, nothing is for free, and silicon photonics has still to solve challenging issues related to strong sensitivity to fabrication tolerances, and to temperature and environmental fluctuations.

Another option is given by the use of multimode polymer waveguide arrays, which are drawing much attention, because they offer high-density wirings with very low-propagation loss, low interchannel crosstalk, high bandwidth, and high coupling efficiency with multimode fiber, VCSELs and photo detectors (PDs). The main issue with this technology is the development of a simple, low-cost and reliable process to fabricate cm-scale long waveguide arrays with inter-waveguide pitches of a few tens of μm.

A very original and surprisingly effective solution has been proposed by Kinoshita and co-workers, who have developed the so called Mosquito method. In this technique UV curable silicone resins are employed for fabricating the core and the cladding of polymer optical waveguides. The core resin is dispensed into the cladding resin, deposited in a liquid phase on a substrate, from a needle mounted on a syringe, whose position is controlled by a horizontally scanning robot. After UV curing and baking of the core and cladding resins, a circular-shaped core waveguide with a graded-index profile is magically obtained. This method allows to simplify the fabrication of polymer optical waveguides, since it no longer needs photomasks, large-scale UV exposure apparatus, and chemical etching processes. Further, graded index core waveguides exhibit better performance than step-index waveguides in terms of loss and mutual optical crosstalk.

By optimizing the fabrication process, in this work waveguide arrays with a circular core of 50 μm and a pitch as small as 62.5-μm have been realized, with an impressive control of waveguide size, spacing and circularity. The suitability of the Mosquito-method for high-bandwidth-density on-board and board-to-board optical interconnects is confirmed by the demonstration of 12 × 11.3 Gbps signal transmissions in an array of 12 waveguides array without any signal deterioration.

This successful result is a clear demonstration that technological processes must not be stuck to conventional schemes, because different ways of thinking are the primary key for the largest advances. It is difficult to say now if the Mosquito method has the potential to compete with more consolidated photonic technologies, but it is always good to have alternative routes to follow. Let’s wait for more news from Kinoshita and co-workers.

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