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Spotlight on "Freeform Three-Dimensional Embedded Polymer Waveguides Enabled by External-Diffusion Assisted Two-photon Lithography"

https://www.osapublishing.org/spotlight/summary.cfm?id=336977 by H. H. D. Nguyen, U.

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by Hollenbach, U. Ostrzinski, K. Pfeiffer, S. Hengsbach, J. Mohr

Spotlight summary:

High-index contrast waveguides now go 3D on a photonic chip.

One of the main limits of planar lightwave circuits is that they are… planar indeed! Giving optical waveguides a third dimension would offer more flexibility to overcome the density and complexity limits of conventional photonic integrated architectures, with large benefits in optical interconnects applications.

Direct laser writing is an established technique to fabricate free-form 3D optical waveguides, but until now it was assumed to be not suitable for realizing high-index-contrast single-mode waveguides. Untrue, actually, because Nguyen and coworkers have just got it. They exploited 3D femtosecond-laser curing of a newly developed photopolymer, followed by diffusion of a lower-index gaseous monomer. The diffusion of the guest monomer is the key of their method. It leads to a strong reduction of the refractive index of the uncured host polymer, as large as 0.013; in contrast, the refractive index of the laser-cured polymer, namely the waveguide core, is almost unaffected by the monomer diffusion process.

This technique maintains all the main advantages of conventional 3D laser writing schemes, such as the possibility of writing multilayers of waveguides without any stacking or alignment effort, the need for neither wet chemical nor etching processes, and the use of only one layer of a single material. And waveguide propagation loss (0.37 dB/cm at 850 nm) is nicely low. The monomer diffusion time, now in the order of several tens of hours, is a bit long, but Nguyen and coworkers are confident that it can be reduced to better meet commercial requirements

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