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One-Dimensional Photonic Crystal Channel Waveguides Micromachined Using a Femtosecond Laser

William Carver*

Department of Electro-Optical Engineering, University of San Francisco, San Francisco, USA

Introduction

The creation of integrated photonic crystal waveguides inside a transparent polymer using a femtosecond laser is described. In general, waveguide construction using femtosecond laser-induced positive refractive index changes is possible. However, in transparent polymers, their performance is limited because this approach can only achieve tiny refractive index changes. These limitations can be overcome by creating hexagonal "photonic lattice like" waveguides with negative refractive index alterations in the cladding, which allow light to be contained in the uneradicated core. The manufacturing of this new class of polymer waveguide, as well as the characterization of its numerical aperture, mode field diameter, and attenuation, are all investigated in depth. Integration of Bragg gratings based on positive and negative refractive index modulations within the system is also possible [1].

Description

Integrated optics is a rapidly evolving topic that continues to garner significant interest in both application and basic research. Femtosecond laser inscription of optical elements inside planar silica or crystal substrates, in particular, has matured into a mature technology, with applications in optical sensing, communications, quantum computing, and astronomy [2]. A localised change in the refractive index can be achieved inside a transparent material via nonlinear absorption of the laser pulse energy. Curved waveguides 2D and 3D couplers, interferometers, and Bragg gratings have all been proven using the direct writing approach since it allows for 3D design freedom. The induced refractive index shift and geometrical shape of the produced waveguides are important properties. However, proven fabrication procedures for transparent polymers, an emerging material class for lab-on-a-chip applications, still rely on intense UV irradiation rather than femtosecond laser pulses [3]. Integrated optical elements such as waveguides or gratings can be created using illumination masks or interference effects, and are mostly but not exclusively employed in sensor applications. While these procedures have a high level of performance, they have limited design freedom, are usually limited to the substrate's surface, and the shape of the induced refractive index alteration is difficult to manage [4]. There have been numerous reports on refractive index shifts in both the positive and negative directions in polymethylmethacrylate utilising ultrashort laser pulses instead of UV light, depending on the applied processing conditions, such as laser pulse repetition rate and laser wavelength [5]. However, photonic structures created by femtosecond laser pulses in planar transparent polymer substrates are still limited to simple topologies such as internal waveguides and couplers in the current state of the art.

Conclusion

We provide a new approach for creating internal waveguides in PMMA dubbed polymer photonic crystal waveguide in this paper the concept is based on a "photonic lattice like" structure that has been used to generate optical waveguides in crystals. Optical wave guiding inside the pristine core is enabled by a hexagonal pattern of modifications that introduces a negative effective refractive index shift to the waveguide's cladding. The waveguide's structure is based on solid core photonic crystal fibres. Total internal reflection, which is achieved by an effective volume average refractive index difference between a central core region and the surrounding photonic crystal cladding and does not rely on the photonic bandgap effect that is typically present in photonic crystal cladding, provides guidance.

References

1. Surdo, Salvatore and Giuseppe Barillaro. "Impact of fabrication and bioassay surface roughness on the performance of label-free resonant biosensors based on one-dimensional photonic crystal microcavities." *ACS Sens* 5 (2020): 2894-2902.

2. Wang, Fei, Wu Yuan, Ole Hansen and Ole Bang. "Selective filling of photonic crystal fibers using focused ion beam milled microchannels." *Opti Expr* 19 (2011): 17585-17590.

3. Li, Ming, Kiyotaka Mori, Makoto Ishizuka and Xinbing Liu, et al. "Photonic bandpass filter for 1550 nm fabricated by femtosecond direct laser ablation." *Appli Phys Lett* 83 (2003): 216-218.

4. Lv, Jinman, Yazhou Cheng, Weihao Yuan and Xiaotao Hao. "Three-dimensional femtosecond laser fabrication of waveguide beam splitters in LiNbO 3 crystal." *Opti Mater Expr* 5 (2015): 1274-1280.

5. Sohn, Ik Bu, Young Seop Kim, Young Chul Noh and Jin Chang Ryu. "Microstructuring of optical fibers using a femtosecond laser." *J Opti Soci Koer* 13 (2009): 33-36

***Address for Correspondence:** William Carver, Department of Electro-Optical Engineering, University of San Francisco, San Francisco, USA; E-mail: williamcarver@gmail.com*

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