

Thermo-optic Effect in Hybrid Polymer/Silica Photonic Crystal Fibers

Photonic crystal fibers, also known as microstructured or holey fibers, have recently generated great interest in the scientific community due to the new ways provided to control and guide light, not obtainable with conventional optical fibers. Proposed for the first time in 1996 from Philip Russell, photonic crystal fibers have driven an exciting and irrepressible research activity all over the world, starting in the telecommunication field and then touching metrology, spectroscopy, microscopy, astronomy, micromachining, biology and sensing. Most photonic crystal fiber has been fabricated in silica glass (other glasses and materials have also been used to obtain particular optical properties such as high optical non-linearity).

On the other hand, poly-dimethylsiloxane (PDMS) is a polymeric silicone material widely used in the area of photonics, particularly in opto/microfluidics, having unique optical properties such as transparency for a wide range of wavelength, high elasto-optic and thermo-optic coefficients, biocompatibility are some of its features. PDMS combined with its low cost and ease fabrication procedure is considered as a potential active material for tunable devices and sensing applications. Therefore, in this work, we demonstrate for the first time the combination of the aforementioned polymeric material with a commercially available photonic crystal fiber, with aim to develop a tunable fiber device, sensitive to external perturbations such as temperature.

In the beginning, we investigated numerically with the help of Prof. K. Vlachos (Department of Computer Engineering and Informatics of University of Patras) the basic guiding properties of the hybrid PDMS/silica structure using Finite Time Difference Domain (FDTD) method. We observed that under a constant bend of the fiber, the bend-induced power loss could be recovered by simply increasing the temperature. The reason is that the high thermo-optic coefficient (i.e. change of refractive index of polymer/ $^{\circ}\text{C}$) of PDMS can act in a way to partially reconstruct the fundamental guiding mode highly attenuated by bending losses. This of course resulted to increment of the total transmitted power of the fiber. Consequently the next step was to proceed to experimental investigation of the proposed structured where all initial theoretical results verified. In our paper, we present experimentally a 6% recovery of the power suffering from bending attenuation for a range of temperatures up to 75°C .

We believe that the presented hybrid PDMS/silica fiber has the potential to be used for macro-bend sensing, whereas the feature of power recovery with temperature, further enhances the ability of the fiber to act as temperature-tuned device over a wide range of wavelengths. All the experiments performed in TPCI, NHRF where part of the modeling and numerical calculations in University of Patras.

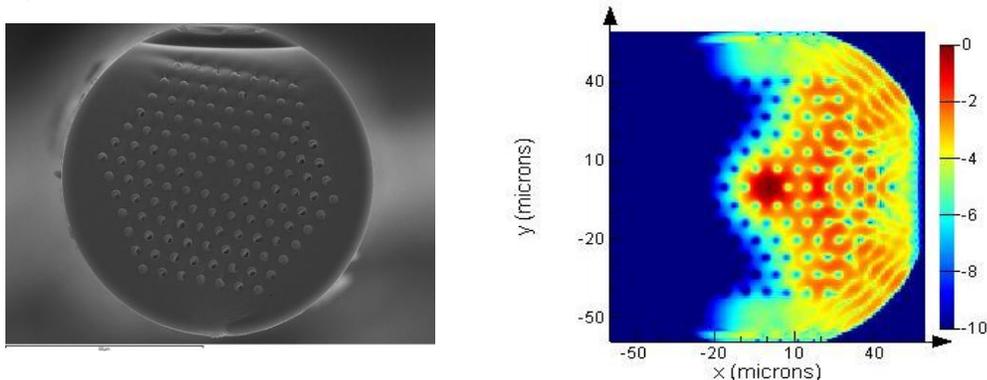


Fig.1 Hybrid PDMS/silica photonic crystal fiber (left). Hybrid Photonic crystal fiber suffering from bending attenuation: Electric field distribution of the fundamental mode (right).

Journal Reference

Christos Markos, Kyriakos Vlachos, George Kakarantzas

Bending loss and thermo-optic effect of a hybrid PDMS/silica photonic crystal fiber

Optics express 18, 24344 (2010)

DOI: <http://dx.doi.org/10.1364/OE.18.024344>

Image link:

<http://www.opticsinfobase.org/oe/viewmedia.cfm?uri=oe-18-23-24344&seq=1>

TPCI/NHRF paper was chosen as image of the week (08 November 2010) by the central web site of the Optical Society of America.

The screenshot shows the OpticsInfoBase website interface. At the top, the OSA logo and 'OpticsInfoBase' branding are visible, along with navigation links like 'Custom Alerts', 'Subscribe', 'Login Benefits', 'Contact Us', 'My InfoBase', and 'Login'. A dropdown menu for 'Select Another Publication' is also present.

The main content area is divided into several sections:

- Current OSA Journals:** A list of journals including Adv. Opt. Photon., Applied Optics, Biomed. Opt. Express (New!), J. Opt. Soc. Am. A, J. Opt. Soc. Am. B, Optics & Photonics News, Optics Express, Optics Letters, Spotlight on Optics, and Virtual J. Biomed. Opt.
- Partnered Journals:** A list of journals including Applied Spectroscopy, Chinese Optics Letters, J. Display Technol., J. Lightwave Technol., J. Opt. Commun. Netw., J. Opt. Soc. Korea, and J. Opt. Technol.
- Legacy Journals:** A list of journals including J. Opt. Netw. (2002-2009), J. Opt. Soc. Am. (1917-1983), and Optics News (1975-1989).
- OSA Conferences:** A list including Conference Papers.
- Special Collections:** A list including Laser Era in the USSR and Early OSA Presidents.

The right sidebar contains:

- What's New:** A section with news items, including 'Oct 11 2010: Custom Journals and Custom TOCs have been added to My InfoBase', 'Sep 13 2010: The new Energy Express supplement issue is now available featuring the Thin-Film Solar Cells focus issue', and 'Sep 01 2010: The new issue of Biomedical Optics Express is now available!'. An 'Image of the week' from November 8, 2010, is also featured.
- Top Article Downloads:** A section for 'October 2010' with a list of top articles.
- Open Access Journals:** A list of three articles.
- Subscription Journals:** A list of three articles.
- Top Downloads by Journal:** A section for journal-specific downloads.

At the bottom, there is a search bar with 'Basic Search', 'Advanced Search', 'Lookup / Browse', and 'Search Tips' tabs. Below the search bar, it says 'Search across all available journals and conference papers published by OSA. Browse by topic or by recent ToC categories. If you need help, read our search tips.' There are also 'Search' and 'New Search' buttons.

On the left side, there are several promotional banners and links:

- Home, About, Help, Interactive Pubs (ISP), My InfoBase
- Authors, Readers, Librarians, Member Subscribers
- ADVERTISEMENTS: 'See more. Learn more. Watch Newport's newest videos on YouTube' with a 'Click Here' button and Newport logo.
- 'New Era of Lab Buddy' banner.
- 'CLEO:2011 1-6 May 2011 Baltimore, MD, USA Submission Deadline: 2 December 2010' banner.
- 'ISP OSA Interactive Service Publishing Already Tried ISP? Take the Survey!' banner.
- 'BioOptics WORLD FREE SUBSCRIPTION!' banner.

At the bottom right, there is a 'crosscheck depositor' logo.