“Bragg gratings in step-index polymer optical fibers: photo-inscription and characterization for sensing applications”

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Abstract of PhD thesis

In this thesis report, both fiber Bragg grating (FBG) photo-inscriptions in polymer optical fibers (POFs) and their sensing applications are discussed. During my thesis work, only poly(methyl methacrylate) (PMMA) POFs were used. They were manufactured at the Hong Kong Polytechnic University. They are characterized by a core diameter of 8.2 μm and a cladding diameter of 150 μm. The cladding is in pure PMMA while the core is composed of PMMA doped with diphenyl sulfide (DPS) (5 % mole) and trans-4-stilbenemethanol (TS) (1 % w.t.). The dopants are used to increase the refractive index and enhance the photosensitivity, respectively.

FBGs were photo-inscribed using a Helium-Cadmium (He-Cd) continuous wave (CW) laser with 30mW power at 325nm and the phase mask technique. A photo-inscription set-up was implemented during the first year of the PhD thesis. Thanks to this set-up, highly reflective FBGs 97 % were produced in step-index PMMA POFs. It was shown that a slight decrease of the fiber cladding thickness (obtained through an etching process) can help achieving a higher reflectivity. We also found that the thermal pre-treatment for POFs can increase the FBG inscription successful rate and the post-treatment for polymer optical fiber Bragg gratings (POFBGs) can stabilize or even enhance the FBG reflectivity. This photo-inscription setup is also applicable to tilted fiber Bragg grating (TFBG) inscriptions with a slightly tilt of the phase mask.

Finally, sensing applications in temperature, axial force, transverse force and surrounding refractive index (SRI) were conducted. Based on different physical properties compared to silica fibers, POFBGs have larger sensitivity in temperature, axial force, transverse force. Because PMMA POFs have large bending tolerance and good biocompatibility, POFBGs have great potential for *in vivo* sensing applications.