Photonic microstructures in optical fiber and their sensing applications (M.Sc. Seminar)

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ABSTRACT: Optical fiber sensors have attracted significant interests in their physical properties and potential applications for their advantages of compact size, light weight, immunity to electromagnetic interference and operation in harsh environment. To achieve their potential applications, it is important to reveal the underlying physics through both experimentation and simulation, which is mostly lacking so far. In this study, microstructures in optical fiber, such as tapers and multilayers, as well as their associated photonic components, such as long period grating (LPG), are investigated by simulation with COMSOL Multiphysics software, which is also compared with experiments performed in this study or the experimental results achieved by this group. In the experimentation of this study, the effects of different fabrication parameters on the formation of micro-taper in optical fiber and the transmission spectra of resulted LPGs are carried out, which indicates that the average diameter of the micro-taper decreases and a blue-shift in the transmission spectrum of the LPG occurs by increasing any of the three fabrication parameters such as arc current, arc duration, and tension along the fiber. The sensitivities of LPG to surrounding refractive index and temperature are studied computationally, which shows the highest sensitivity of refractive index of 621.4 nm/RIU and the temperature sensitivity of 10 pm/℃. Furthermore, tapered fibers in the configurations of either single or in-line Mach-Zehnder interferometer are studied as biosensors for detecting the concentration of Streptavidin (SV) protein computationally and compared with the experimental results previously obtained in our research group. The simulation results show good agreement with the experimental results indicating the effective refractive indices of the coating materials play a significant role in determining the sensitivity. The findings achieved from this study are helpful for designing LPG-base and tapered fiber-base optical fiber sensors and biosensors, which enable the applications of these optical sensors in various fields, such as telecommunication, chemistry, medical and environmental sciences.

ALL ARE WELCOME!