Abstract

This thesis focuses on the design and numerical simulation of an optical fiber sensor using the finite element method by COMSOL Multiphysics software. The designed sensors based on the principle of surface plasmon resonance have been utilized for refractive index detection. Based on the achieved objectives in the present research work, the thesis has been organized into six chapters. **Chapter 1** serves as an introduction, providing readers with an overview of optical fiber, surface plasmons, SPR technique in various configurations and numerical simulation study. An introduction to various types of sensors and highlights their advantages. This chapter also includes a comprehensive literature review of optical fiber SPR sensor as well as the motivation behind this thesis. In last the section of the chapter provides an overview of the literature review and the objectives that are addressed in the thesis. **Chapter 2** presents the metal thin layer coated D-shaped fiber based SPR sensor and analyses performance results for all Au, Ag and Cu metal layers one by one. The sensitivity is determined by the wavelength interrogation technique. The average and maximal sensitivity of the sensor increase as the thickness of the metal layer increases. I have found that gold (Au) metal layer shows the maximum sensitivity compared to the silver (Ag) and copper (Cu). This sensor is used to detect analyte samples with a refractive index within the range of 1.33-1.42. The designed optical fiber sensor with enhanced sensing performance can be utilized as a refractive index sensor in a wide range of chemical and biological sensing applications. **Chapter 3** describes the simulation study of gold nanowire utilized RI detection SPR sensor by the COMSOL Multiphysics software. Based on average sensitivity, maximum sensitivity, resolution, and figure of merit (FOM), I have analyzed the sensor performance. This sensor model demonstrated significant sensitivity for the analyte sample RI range of 1.33-

1.43. Fabrication tolerance error also explained for sensor structure parameters. **Chapter 4** presents the metal oxide (Al-doped ZnO) plasmonic materials deposited D-type fiber based refractive index SPR sensor. For results performance, Ihave calculated the sensitivity, resolution, and analyte detection range. In addition, experimental fabrication techniques and fabrication tolerance error are discussed. The SPR sensor can detect analytes samples of low RI, such as drugs inspection and monitoring, biological and organic species, and other chemical analyte samples. **Chapter 5** describes the hollow-core fiber based high RI detection SPR sensor. This sensor is able to detect the long-range refractive index of analytes with a high level of performance. By analyzing the loss peak position sifting, we determined sensor performance results in the analyte sample RIs range of 1.45-1.52. This sensor efficiently detects high RI analyte samples that are filled into the hollow core. The conclusive findings of the entire study are summarized in the final **Chapter 6**. Within this chapter, I comprehensively explore the performance results and application domains of all the designed sensors. Additionally, plans for future research on this topic are outlined.