

# Table of Content

<b>Certificate .....</b>	<b>ii</b>
<b>Declaration by the candidate .....</b>	<b>iii</b>
<b>Copyright transfer certificate .....</b>	<b>iv</b>
<b>Acknowledgments .....</b>	<b>v</b>
<b>List of Figures.....</b>	<b>xiii</b>
<b>List of Table.....</b>	<b>xvii</b>
<b>Nomenclature .....</b>	<b>xix</b>
<b>Abstract.....</b>	<b>xxi</b>
<b>Chapter 1 Introduction and Motivation .....</b>	<b>23</b>
1.1 History of Photonic Crystals.....	25
1.2 Photonic crystals .....	25
1.2.1 One-dimensional (1-D) photonic crystals .....	26
1.2.2 Two-dimensional (2-D) photonic crystal.....	27
1.2.3 Three-dimensional (3-D) photonic crystal.....	28
1.2.4 Natural photonic crystal.....	29
1.3 Photonic sensors.....	30
1.4 Optical fiber .....	31
1.4.1 Optical fiber sensors .....	33
1.4.2 Merits and Demerits of optical fiber technology.....	34
1.5 Photonic crystal fiber.....	35
1.5.1 Classification of photonic crystal fiber .....	36
1.5.1.1 Solid–Core photonic crystal fiber .....	36
1.5.1.2 Hollow–Core photonic crystal fiber.....	38
1.6 Photonic crystal fiber sensor.....	39
1.6.1 Sensing mechanism-based PCF sensors .....	40
1.6.1.1 Internal sensing mechanism based PCF sensor.....	40
1.6.1.2 External sensing mechanism based PCF sensor.....	41
1.6.2 Application based PCF sensors .....	42
1.6.2.1 Physical sensors .....	42
1.6.2.2 Chemical sensors.....	43
1.6.2.3 Bio sensors .....	43
1.7 Different numerical methods for PCF structure modeling.....	44
1.7.1 Finite difference time domain method (FDTD) .....	45

1.7.2 Finite Element Method (FEM) .....	45
1.8 Finite element method for PCF utilizing COMSOL Multiphysics software.....	46
1.9 Principles and properties of different theoretical methods for PCF structure analysis.....	48
1.9.1 Sellmeier’s equation for material dispersion.....	48
1.9.2 Effective mode index of PCF .....	49
1.9.3 Confinement loss .....	49
1.10 Surface plasmon resonance theory accompanied with PCF structure.....	50
1.11 Fabrication of PCF .....	53
1.12 Advantage of photonic crystal fiber sensors.....	55
1.13 Literature review .....	56
1.14 Motivation.....	58
1.15 Objective of this Thesis .....	59
<b>Chapter 2 Study of highly sensitivity metal wires assisted photonic crystal fiber based refractive index sensor.....</b>	<b>61</b>
2.1 Introduction.....	63
2.2 Model and theoretical analysis.....	65
2.3 Simulation result and discussion.....	67
2.4 Conclusion .....	79
<b>Chapter 3 Design of surface plasmon resonance based on both side polished photonic crystal fiber for highly efficient refractive index sensor.....</b>	<b>81</b>
3.1 Introduction.....	83
3.2 Theoretical description .....	86
3.3 Result and discussion .....	89
3.4 Conclusion .....	99
<b>Chapter 4 Rectangular shape cladding based photonic crystal fiber surface plasmon resonance based refractive index sensor.....</b>	<b>101</b>
4.1 Introduction.....	103
4.2 Theoretical description .....	106
4.3 Result and Simulation .....	108
4.4 Fabrication Technique .....	116
4.5 Conclusion .....	118
<b>Chapter 5 Dual-Core photonic crystal fiber based plasmonic sensor for a broad range of refractive index sensing.....</b>	<b>119</b>
5.1 Introduction.....	121
5.2 Structural design and theoretical model .....	123

5.3 Result and Discussion .....	125
5.4 Fabrication method.....	138
5.5 Conclusion .....	138
<b>Chapter 6 Summary and Future Scope .....</b>	<b>141</b>
6.1 Summary.....	143
6.2 Conclusion .....	144
6.3 Future scope.....	147
<b>References.....</b>	<b>149</b>
<b>List of Publications .....</b>	<b>171</b>