

Contents

Abstract	i
Declaration	ix
Certificate	x
Acknowledgment	xii
Dedication	xv
Contents	xvi
List of tables	xxi
List of figures	xxii
List of abbreviations	xxviii
List of symbols	xxx
1 Introduction	1
1.1 A brief overview of Raman scattering	1
1.1.1 The discovery of Raman effect	2
1.1.2 Theory of Raman scattering	2
1.1.3 Raman instrumentation	7
1.1.4 Limitation of Raman spectroscopy	8
1.2 Surface enhanced Raman scattering (SERS) and its discovery	8

1.2.1	Electromagnetic enhancement	9
1.2.2	Chemical enhancement	11
1.3	Enhancement factor	12
1.4	SERS substrate	13
1.5	Different approaches to develop SERS substrate	14
1.6	Scope of the thesis and statement of the thesis problem	19
	References	21
2	Simulation and fabrication of metal nanostructures to study coupled LSPR field magnitude for SERS based sensing investigation	35
2.1	Introduction	35
2.2	Design of metal nanostructure for maximum LSPR field condition	36
2.2.1	Periodically varying height Au nanopillar	37
2.2.2	Design of diagonally aligned squared Au nanostructure and simulation study	43
2.3	Fabrication of nanostructure	44
2.3.1	Experimental	45
2.4	Results and discussion	47
2.4.1	Characterization of the substrate	47
2.5	Summary	49
	References	50
3	Fabrication of SERS substrate from naturally available diatom for detection and quantification of chemicals	53
3.1	Introduction	53

3.2 Experimental	54
3.2.1 Material	54
3.2.2 Diatom frustule processing	55
3.2.3 SERS substrate preparation from diatom frustule	55
3.2.4 Analyte sample preparation	57
3.2.5 Simulation study of LSPR field magnitude of the proposed substrate	57
3.3 Results and discussions	59
3.3.1 Characterization of the substrate	59
3.3.2 Fluoride level in water	64
3.4 Summary	65
References	66
4 Development of SERS substrate from printing grade paper and its application for monitoring of glucose and urine	69
4.1 Introduction	69
4.2 Experimental	71
4.2.1 Materials	71
4.2.2 Synthesis of AgNPs colloidal solution	71
4.2.3 SERS substrate preparation	71
4.2.4 Analyte sample preparation	73
4.2.5 Simulation study of LSPR field magnitude of the proposed substrate	73
4.3 Results and discussion	74
4.3.1 Characterization of the substrate	74

4.3.2	Glucose and artificial urine detection	79
4.4	Summary	80
	References	81
5	Gold-coated electrospun PVA nanofibers as SERS substrate for detection of pesticides	83
5.1	Introduction	83
5.2	Experimental	85
5.2.1	Materials	85
5.2.2	SERS substrate fabrication and Raman signal measurement system	85
5.2.3	Analyte sample preparation	86
5.2.4	Electromagnetic (EM) simulation study	87
5.3	Results and Discussions	88
5.3.1	Characterization of the substrate	88
5.3.2	Detection of pesticides	94
5.4	Summary	98
	References	98
6	SERS substrate realization using Blu-ray DVD and reliable detection of albumin, creatinine and urea in urine sample	105
6.1	Introduction	105
6.2	Materials and Methods	106
6.2.1	Materials	106
6.2.2	SERS substrate fabrication and Raman signal measurement system	107

6.2.3	Electromagnetic (EM) simulation study	108
6.2.4	Analyte sample preparation	108
6.3	Results and Discussions	110
6.3.1	Characterization of the substrate	110
6.3.2	Detection of albumin, creatinine and urea	114
6.4	Summary	119
	References	121
7	Conclusions, limitations and future prospects	123
7.1	Conclusions	123
7.2	Limitations	126
7.3	Future prospect	127
	List of publications	129