

Contents

Abstract	i
Declaration	ix
Certificates	x
Acknowledgement	xii
Table of Contents	xiv
List of Tables	xvii
List of Figures	xix
List of Abbreviations	xxv
List of symbols	xxvi

Chapter I: Introduction

1.1 Background	1
1.2 Insects, moths and butterflies	11
1.3 Avian and Aquatic systems	15
1.4 Plant system	16
1.5 Motivation	18
1.6 Thesis objective and structure	19
References	23

Chapter II: Physical characterisation: tools and techniques employed

2.1 Digital scientific camera and optical microscope	30
2.2 Scanning electron microscopy (SEM)	31
2.3 UV-Vis-NIR reflectance spectroscopy	32
2.4 Contact angle studies using contact angle meter	34
References	35

Chapter III: Surface roughness mediated-wettability and reflectance characteristics of dragonfly and damselfly wings

3.1	Specimen collection and sectioning	38
3.2	Morphological analysis of the dragonfly and blue river-damselfly wings	39
3.3	Wettability studies on the hind-wing parts	42
3.4	Theoretical treatments on wettability conditions	44
3.5	Reflectance characteristics of the hindwings and contributory roles of surface roughness	48
3.6	Conclusion	52
	References	53

Chapter IV: White-appearing structural color in the wings of butterflies belonging to *Lepidoptera* order but diverse sub-families and their water-repellency features

4.1	Specimen collection and treatment	59
4.2	Microstructural analyses of the butterfly wing scales	60
4.3	Reflectance spectra of the butterfly wings soaked in ethanolic media	63
4.4	Reflectance features w.r.t. variable incident angle and polarisation sensitivity	68
4.5	Representative chromaticity diagrams of the butterfly wings	74
4.6	Wetting de-wetting phenomena in the butterfly wings	75
4.7	Conclusion	81
	References	83

Chapter V: Surface-wettability and structural colouration property of naturally occurring soft matter: (*Indian Rosacea*) flower petals

5.1	Specimen collection and processing	89
5.2	Micro-morphological analysis of rose petals	90

5.3	Surface wettability property of rose petals	91
5.3.1	Model on micro-papillae assembly and theoretical treatment	91
5.3.2	Experimental features on wetting-dewetting transition	94
5.4	Structural colouration in light-to-dark pink rose petals	99
5.4.1	Manifestation of reflectance features	99
5.4.2	Chromaticity features - A comparative view	103
5.5	Conclusion	105
	References	105

Chapter VI: Exploring bi-functional properties of certain *Hibiscus rosa-sinensis* (Chinese rose) flowers belonging to *Malvaceae* family

6.1	Specimen collection and treatment	111
6.2	Micro-morphological analysis of hibiscus petals	112
6.3	Assessment of the wettability features of the fresh hibiscus petals	113
6.4	Normal and variable incident angle reflectance features	117
6.4.1	Structural colouration character in different Hibiscus petals	117
6.4.2	Chromaticity diagram	123
6.5	Conclusion	124
6.2	References	125

Chapter VII: Conclusions and future direction 128

Appendix

Publications

Addenda