

Contents

Abstract	i
Declaration	x
Certificates	xi
Acknowledgement	xiii
Table of Contents	xv
List of Tables	xix
List of Figures	xx
List of Abbreviations	xxvii
List of symbols	xxix
Chapter I: Introduction	
1.1 Background	1
1.2 Chalcogenides and transition metal dichalcogenides	3
1.3 Photocatalytic activity of nanomaterials/TMDC	9
1.4 Mechanical and tribological properties	10
1.5 Effect of ion irradiation on nanomaterials	12
1.6 Motivation	14
1.7 Thesis objective and structure	15
References	19
Chapter II: Synthesis and characterization of different forms of tungsten disulphide nanosystems	
2.1 Synthesis routes and physical characterization techniques employed	27

2.2	Inorganic fullerene (IF) type - WS ₂ nanoparticles	28
2.2.1	Hydrothermal synthesis	28
2.2.2	Structural and morphological characteristics of IF-WS ₂	29
2.2.3	Optical and spectroscopic properties	33
2.3	WS ₂ nanosheets	37
2.3.1	Hydrothermal synthesis cum exfoliation	37
2.3.2	Structural and morphological characteristics	38
2.3.3	Optical and spectroscopic characteristics	41
2.3.4	N ₂ adsorption-desorption features	43
2.4	WS ₂ /C-dot nanohybrid systems	45
2.4.1	Synthesis from powder to 2D and nano-hybrid systems	45
2.4.2	Structural and morphological analyses	46
2.4.3	Characteristic growth mechanism	49
2.5	Conclusion	50
	References	51

Chapter III: Raman and photoluminescence studies of WS₂/C-dot nanohybrid systems

3.1	Principles of light scattering and light emission processes	56
3.2	Raman active modes in the WS ₂ /C-dot nanohybrid system	57
3.3	Ordinary and excitation dependent photoluminescence	59
3.4	Excitation dependent luminescence feature of WS ₂ /C-dot nanohybrid	60

3.5	Conclusion	64
	References	64

Chapter IV: Photocatalytic activity of the nanoscale WS₂ against harmful pollutants

4.1	Target dyes and role of photocatalysis	68
4.2	Photocatalytic activity of IF-type WS ₂ nanoparticles and WS ₂ nanosheets	69
4.3	Photocatalytic performance of WS ₂ /C-dot nanohybrid system	75
4.4	Origin of enhanced bifunctional property of WS ₂ /C-dot systems	78
4.5	Conclusion	79
	References	79

Chapter V: Mechanical property and surface wettability features of IF-type WS₂ nanoparticles dispersed in a polymer

5.1	Processing and characterisation of IF-type nano-WS ₂ /PVA composites	83
5.2	Structural and morphological analyses	84
5.3	FT-IR spectroscopy and thermo-gravimetric studies	88
5.4	Mechanical and tribological features	91
5.5	Surface wettability features of nano-WS ₂ -dispersed PVA films	95
5.6	Conclusion	100
	References	100

Chapter VI: Effect of low energy Xe⁺ ion irradiation on WS₂ nanosheets		
6.1	Irradiation experiment on WS ₂ nanosheets	106
6.2	Post-irradiation analyses	107
6.2.1	Microstructure and surface morphology	108
6.2.2	Radiative emission, Stoke's shift and Raman modes	114
6.2.3	Transition from hydrophilic (wetting) to hydrophobic (dewetting) surface features	118
6.3	Conclusion	120
	References	120
Chapter VII: Conclusions and future direction		123
Appendix		
Publications		
Addenda		