

Contents

Abstract	i-iii
Declaration	iv
Certificate	v
Certificate of the External Examiner	vi
Acknowledgment	vii-viii
Contents	x-xii
List of Figures	xiii-xviii
List of Tables	xix
Nomenclature	xx-xxv
 Chapter 1: Introduction	 1-25
1.1. Background.....	2
1.1.1. 1D-Material based FET.....	3
1.1.2. 2D-Material based FET.....	6
1.2. Research Objectives.....	15
1.3. Thesis Organization.....	16
Bibliography	
 Chapter 2: Literature Review	 26-60
2.1. Introduction.....	27
2.2. Properties of 2D-WS ₂	27
2.2.1. Structural Analogy of 2D-WS ₂ Materials.....	29
2.2.2. Energy Band Structure and Bandgap Tuning of WS ₂	32
2.2.3. Synthesis Processes of Layered 2H-WS ₂ Material.....	35
2.2.3.1. Top-down Synthesis.....	35
2.2.3.2. Bottom-up Synthesis.....	37
2.2.4. Techniques of 2D Material Transfer Methods for Electronic Devices Fabrication.....	39
2.2.4.1. Wet Transfer.....	39

2.2.4.2. Dry Transfer.....	40
2.3. 2H-WS ₂ in FET Application.....	40
2.3.1. Back Gate WS ₂ -FET Structure.....	41
2.3.2. Top Gate WS ₂ -FET Structure.....	42
2.3.3. Dual Gate WS ₂ -FET Structure.....	43
2.4. Metal-Semiconductor Interface.....	45
2.4.1. Doping of WS ₂	46
2.5. Methodologies/Approaches Applied.....	50

Bibliography

Chapter 3: Synthesis of WS₂ Nanosheets Using Surfactant-Assisted

Method 61-80

3.1. Introduction.....	61
3.2. Liquid Phase Exfoliation Method of WS ₂ Nanosheets.....	64
3.3. Spectroscopy Measurements.....	66
3.3.1. Raman Spectroscopy.....	66
3.3.2. UV-Vis Spectroscopy.....	68
3.3.3. Photoluminescence.....	69
3.3.4. X-Ray Diffraction Spectroscopy.....	70
3.3.5. Atomic Force Microscopy.....	71
3.3.6. Field Emission Scanning Electron Microscopy.....	73
3.3.7. High-Resolution Transmission Electron Microscopy.....	74
3.4. Summary.....	76

Bibliography

Chapter 4: Effect of Cl Doping on Structural and Electrical Properties of Exfoliated WS₂ Nanosheets 81-110

4.1. Introduction.....	82
4.1.1. Impact of Metal Work-Function on Contact Properties in TMD Materials.....	83
4.1.2. Strategy to Improve the M-S Interface by Inducing the Interfacial Layer.....	86
4.1.3. Surface Modification by Dopant Atom to Improve the M-S Junction.....	87

4.2.	Experimental Procedure for Doping Technique.....	91
4.3.	Energy Band Calculation of WS ₂	92
4.4.	Spectroscopy Analysis of Undoped and Doped WS ₂ Nanosheet.....	94
4.5.	Electrical Transport Measurement After CI Doping.....	99
4.6.	Summary.....	104
	Bibliography	
Chapter 5:	Fabrication and Characterization of WS₂ FET	111-144
5.1.	Introduction.....	112
5.2.	Experiment.....	115
5.2.1.	WS ₂ -FET Fabrication.....	115
5.2.2.	Electrical Characterization of WS ₂ -FET.....	118
5.3.	Results and Discussion.....	118
5.3.1.	Spectroscopic Analysis of WS ₂ Film Before and After Fabrication.....	118
5.3.2.	Electrical Characterization of WS ₂ -FET.....	121
5.3.3.	Channel length Variation of the WS ₂ -FET.....	127
5.3.4.	Doping Effect in WS ₂ FET.....	129
5.3.5.	Measurement of Threshold Voltage and Intrinsic Mobility Using Y-function Method.....	131
5.3.6.	Measurement of Contact Resistance at the Metal-WS ₂ Interface.....	134
5.4.	Summary.....	138
	Bibliography	
Chapter 6:	Conclusions and Future Direction of Research	145-150
6.1.	Summary of the Thesis.....	146
6.2.	A Few Directions for Future Works.....	149
	List of Publication	