



**METAL
CHALCOGENIDE
NANOSTRUCTURES
FOR RENEWABLE
ENERGY
APPLICATIONS**



Edited by
Ahsanulhaq Qurashi

Metal Chalcogenide Nanostructures for Renewable Energy Applications

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Contents

Preface	xi
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Part 1: RENEWABLE ENERGY CONVERSION SYSTEMS

1 Introduction: An Overview of Metal Chalcogenide Nanostructures for Renewable Energy Applications	3
<i>Ahsanulhaq Qurashi</i>	
1.1 Introduction	3
1.2 Metal Chalcogenide Nanostructures	7
1.3 Growth of Metal Chalcogenide Nanostructures	8
1.4 Applications of Metal Chalcogenide Nanostructures	16
1.5 Summary and Future Perspective	18
References	18
2 Renewable Energy and Materials	23
<i>Muhammad Asif</i>	
2.1 Global Energy Scenario	23
2.2 Role of Renewable Energy in Sustainable Energy Future	25
2.3 Importance of Materials Role in Renewable Energy	27
References	30
3 Sustainable Feed Stock and Energy Futures	33
<i>H. Idriss</i>	
3.1 Introduction	33
3.2 Discussion	34
3.2.1 Nuclear Technology	35
3.2.2 Solar Energy	36
3.2.3 Hydrogen by Water Splitting	38
References	41

Part 2: SYNTHESIS OF METAL CHALCOGENIDE NANOSTRUCTURES

4	Metal-Selenide Nanostructures: Growth and Properties	45
	<i>Ramin Yousefi</i>	
4.1	Introduction	45
4.2	Growth and Properties of Different Groups of Metal-Selenide Nanostructures	48
4.2.1	Metal Selenides from II–VI Semiconductors	48
4.2.2	ZnSe	48
4.2.3	CdSe	54
4.2.4	HgSe	57
4.3	Metal Selenides from III–VI Semiconductors	57
4.3.1	In ₂ Se ₃	58
4.4	Metal Selenides from IV–VI Semiconductors	61
4.4.1	SnSe	61
4.4.1	PbSe	62
4.5	Metal Selenides from V–VI Semiconductors	66
4.5.1	Sb ₂ Se ₃	66
4.5.2	Bi ₂ Se ₃	68
4.6	Metal Selenides from Transition Metal (TM)	69
4.6.1	Copper Selenide (CuSe, Cu ₃ Se ₂)	70
4.6.2	Iron Selenide (FeSe ₂ , FeSe)	71
4.6.3	MoSe ₂	72
4.6.3	WSe ₂	74
4.7	Ternary Metal-Selenide Compounds	75
4.7.1	CuInSe ₂ (Copper Indium Diselenide)	75
4.7.2	CdSSe	76
4.7.3	CdZnSe	77
4.8	Summary and Future Outlook	78
	Acknowledgment	79
	References	79
5	Growth Mechanism and Surface Functionalization of Metal Chalcogenides Nanostructures	83
	<i>Muhammad Nawaz Tahir, Jugal Kishore Sahoo, Faegheh Hoshyargar, Wolfgang Tremel</i>	
5.1	Introduction	84
5.1.2	Structure of Layered Transition Metal Chalcogenides (LTMCs)	87

5.2	Synthetic Methods for Layered Metal Chalcogenides	89
5.2.1	Laser Ablation	89
5.2.2	Arc Discharge	90
5.2.3	Microwave-Induced Plasma	90
5.2.4	Electron Beam Irradiation	90
5.2.5	Spray Pyrolysis	91
5.2.6	Sulfidization with H_2S	91
5.2.7	Hydrothermal	91
5.2.8	Metal Organic Chemical Vapor Deposition (MOCVD) Technique	91
5.2.9	Vapor-Liquid-Solid (VLS) Growth	94
5.2.10	Oxide-to-Sulfide Conversion	95
5.2.11	Hot-Injection Solution Synthesis	98
5.2.12	Liquid Exfoliation	99
5.3	Surface Functionalization of Layered Metal Dichalcogenide Nanostructures	102
5.3.1	Surface Functionalization Based on Polymeric Ligands	102
5.3.2	Surface Functionalization Based on Pearson Hardness	107
5.3.3	Surface Functionalization of Metal Chalcogenides by Silane	110
5.4	Applications of Inorganic Nanotubes and Fullerenes	110
5.4.1	Energy	111
	References	113
6	Optical and Structural Properties of Metal Chalcogenide Semiconductor Nanostructures	123
	<i>Ihsan-ul-Haq Toor and Shafique Khan</i>	
6.1	Optical Properties of Metal Chalcogenides Semiconductor Nanostructures	124
6.1.2	Metal Chalcogenide Nanocrystals	126
6.2	Structural Properties and Defects of Metal Chalcogenide Semiconductor Nanostructures	133
	References	142
7	Structural and Optical Properties of CdS Nanostructures	147
	<i>Y. Al-Douri</i>	
7.1	Introduction	147
7.2	Nanomaterials	150

7.3	II–VI Semiconductors	152
7.4	Sol-Gel Process	155
7.5	Structural and Surface Characterization of Nanostructured CdS	156
7.6	Optical Properties	159
7.7	Conclusion	161
	Acknowledgments	162
	References	162

Part 3: APPLICATIONS OF METAL CHALCOGENIDES NANOSTRUCTURES

8	Metal Sulfide Photocatalysts for Hydrogen Generation by Water Splitting under Illumination of Solar Light	167
	<i>Zhonghai Zhang</i>	
8.1	Introduction	167
8.2	Photocatalytic Water Splitting on Single Metal Sulfide	169
8.2.1	CdS	169
8.2.2	ZnS	170
8.2.2	SnS ₂	172
8.3	Photocatalytic Water Splitting on Multi-metal Sulfide	173
8.3.1	ZnIn ₂ S ₄	173
8.3.2	CuS/ZnS	175
8.3.4	CuGa ₃ S ₅	176
8.3.5	CdS–MoS ₂	177
8.3.6	NiS–CdS	178
8.3.7	Mn–Cd–S	179
8.3.8	PbS/CdS	180
8.3.9	AGa ₂ In ₃ S ₈ (A = Cu or Ag)	180
8.4	Metal Sulfides Solid-Solution Photocatalysts	180
8.5	Summary and Future Outlook	184
	References	184
9	Metal Chalcogenide Hierarchical Nanostructures for Energy Conversion Devices	189
	<i>Ramin Yousefi, Farid Jamali-Sheini, Ali Khorsand Zak</i>	
9.1	Introduction	190
9.1.1	Why Metal Chalcogenide Semiconductors Matter for Energy Conversion	191
9.2	Main Characteristics of Cd-Chalcogenide Nanocrystals (CdE; E = S, Se, Te)	192

9.3	Different Methods to Grow Cd-Chalcogenide Nanocrystals	192
9.3.1	Thermal Evaporation Method to Grow Cd-Chalcogenide Nanocrystals	192
9.3.2	Chemical Bath Deposition Method to Grow Cd-Chalcogenide Nanocrystals	205
9.3.3	Electrochemical Deposition Method to Grow Cd-Chalcogenide Nanocrystals	210
9.3.4	Pulsed Laser Deposition (PLD) Method to Grow Cd-Chalcogenide Nanocrystals	212
9.4	Solar Energy Conversion	212
9.4.1	Modeling of Solar Energy Conversion	213
9.4.2	Semiconductor Solar Cells	216
9.4.3	Hierarchical Branching Nanostructures as Better Solar Energy Harvesting	218
9.5	Cd-Chalcogenide Nanocrystals as Solar Energy Conversion	219
9.5.1	CdS Nanostructures Solar Cells	219
9.5.2	CdSe Nanostructures Solar Cells	223
9.5.3	CdTe Nanostructures Solar Cells	226
9.6	Summary and Future Outlook	230
	References	230
10	Metal Chalcogenide Quantum Dots for Hybrid Solar Cell Applications	233
	<i>Mir Waqas Alam and Ahsanulhaq Qurashi</i>	
10.1	Introduction	233
10.2	Chemical Synthesis of Quantum Dots	235
10.2.1	Single-Step Synthesis of Highly Luminescent Quantum Dots	235
10.2.2	Electrochemical Deposition Method	235
10.2.3	Chemical Aerosol Flow Method	236
10.2.4	Chemical Bath Deposition (CBD)	237
10.3	Quantum Dots Solar cell	238
10.4	Summary and Future Prospects	243
	References	243
11	Solar Cell Application of Metal Chalcogenide Semiconductor Nanostructures	247
	<i>Hongjun Wu</i>	
11.1	Introduction	247
11.2	Chalcogenide-Based Thin-Film Solar Cells	248

11.3	CdTe-Based Solar Cells	249
11.4	Cu(In,Ga)(S,Se) ₂ (CIGS)-Based Solar Cells	251
11.5	Metal Chalcogenides-Based Quantum-Dots-Sensitized Solar Cells (QDSSCs)	253
11.6	Hybrid Metal Chalcogenides Nanostructure-Conductive Polymer Composite Solar Cells	257
11.7	Conclusions	261
	References	262
12	Chalcogenide-Based Nanodevices for Renewable Energy	269
	<i>Y. Al-Douri</i>	
12.1	Introduction	269
12.2	Renewable Energy	272
12.3	Nanodevices	274
12.4	Density Functional Theory	277
12.5	Analytical Studies	278
12.6	Conclusion	284
	References	285
13	Metal Tellurides Nanostructures for Thermoelectric Applications	289
	<i>Salman B. Inayat</i>	
13.1	Introduction	290
13.2	Thermoelectric Microdevice Fabricated by a MEMS-Like Electrochemical Process	290
13.3	Bi ₂ Te ₃ -Based Flexible Micro Thermoelectric Generator	292
13.4	High-Thermoelectric Performance of Nanostructured Bismuth Antimony Telluride Bulk Alloys	293
13.5	Nano-manufactured Thermoelectric Glass Windows for Energy Efficient Building Technologies	294
13.6	Conclusion	296
	References	297
	Index	299

Preface

Meeting impending energy requirements by an ecologically benign approach entails scientific innovations to proficiently produce, store, transfer, and utilize enormous amounts of energy. The critical requirement to attain this goal demands to develop cost-effective materials by imparting novel intriguing features to convert maximum energy from sun and other renewable means.

Metal chalcogenide semiconductor nanostructures present the most important class of nanomaterial that provides highly anisotropic diverse morphologies, described by the efficient transport of electrons and excitons, and has been regarded as the most promising building block for nanoscale renewable energy nanodevices and nanosystems. The growth, characterization, and applications of nanostructures entreat various disciplines of science and engineering. The objective of this book is to illuminate the essentials, underlying science related to semiconductor metal chalcogenide nanostructures fabrication for potential renewable energy applications. The effect is an illustrative snapshot of the latest developments from diverse perspectives in a series of chapters based on synthesis, properties, characterization, and applications of metal sulfide, selenide, and telluride nanostructures from distinguished betrothed researchers.

This book contents are divided into three main sections.

Chapters 1–3 present an overview of increasing greenhouse emissions, recent research and substantial progress reported in the literature, covering formation of 0, 1, 2, and 3 dimensional metal sulfide, selenide, and telluride nanostructures. The application of chalcogenide materials for renewable energy conversion, which includes photovoltaics, hydrogen production, thermoelectrics, fuel cell, supercapacitors, and lithium-ion batteries and their future projections are covered in Chapter 1. The potential impact of materials for alternative energy conversion systems and various important renewable energy alternatives is anticipated in Chapters 2 and 3.

Chapters 4–7 are devoted to comprehensive synthesis of metal chalcogenide (sulfide, selenide, and telluride) nanostructures including inorganic graphenes (layered structures) by various important methods, their characterization and growth mechanism for the formation of enthralling morphologies, and various important protocols for surface functionalization of chalcogenides to improve the processability in technological applications are included in Chapters 4 and 5. The potential to engineer semiconductor nanostructures properties during and after fabrication presents an exciting realms and extensive prospect to simply improve the performance of renewable energy conversion systems. Chapters 6 and 7 provide detailed account of structural and optical properties of semiconductor chalcogenides.

Chapters 8–13 are typically covering applications of metal chalcogenides nanostructures in diverse renewable energy conversion devices. Chapter 8 presents updated works metal sulfide nanostructures for solar-driven hydrogen production through water splitting. Chapter 9 gives brief account on *hierarchical* chalcogenide nanostructures, their properties and applications in energy conversion devices. Chapters 10 and 11 are based on metal chalcogenides in photovoltaic applications. Chapter 12 focuses on theoretical work including indirect band gap calculations results and density functional theory. Chapter 13 focuses on metal telluride nanostructures for thermoelectric devices operating around room temperature.

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Part 1
RENEWABLE ENERGY
CONVERSION SYSTEMS