


Chapter 11


Cost-Effective Chalcogenide-Based Nanocomposite Electrodes for High-Performance Electrochemical and Photoelectrochemical Water Splitting

P. Selvakumar

 <https://orcid.org/0000-0002-3650-4548>


*Department of Science and Humanities, Nehru Institute of Technology,
Coimbatore, India*

T. C. Manjunath

 <https://orcid.org/0000-0003-2545-9160>

Rajarajeswari College of Engineering, India

Santosh Kumar Nathsharma

 <https://orcid.org/0000-0003-3935-2938>

Stewart Science College, India

DOI: 10.4018/979-8-3373-3962-7.ch011

Copyright © 2026, IGI Global Scientific Publishing. Copying or distributing in print or electronic forms without written permission of IGI Global Scientific Publishing is prohibited. Use of this chapter to train generative artificial intelligence (AI) technologies is expressly prohibited. The publisher reserves all rights to license its use for generative AI training and machine learning model development.

ABSTRACT

Water splitting, also known process with immense potential in the global shift toward sustainable energy systems. This process involves breaking down water (H_2O) into its, wind, or hydropower. As the world seeks alternatives to fossil fuels to mitigate climate change and reduce greenhouse gas emissions, hydrogen has emerged as a promising energy carrier due to its high energy content and environmentally friendly combustion, which produces only water as a by-product. demonstrating the decomposition of water using direct current electricity. Since then, the field has evolved significantly, driven by advancements in electrochemical systems, materials science, and catalysis. materials science, and catalysis. Modern water splitting can be broadly categorized into three primary methods: electrolysis, photoelectrochemical (PEC) water splitting, and thermochemical water splitting. Among these, electrolysis is the most mature and widely researched technique, involving the application of electrical energy to drive the non-spontaneous reaction.

INTRODUCTION TO WATER SPLITTING AND HYDROGEN PRODUCTION

Water splitting, also known process with immense potential in the global shift toward sustainable energy systems. This process involves breaking down water (H_2O) into its wind or hydropower. As the world seeks alternatives to fossil fuels to mitigate climate change and reduce greenhouse gas emissions, hydrogen has emerged as a promising energy carrier due to its high energy content and environmentally friendly combustion, which produces only water as a by-product, (Tari, 2015a; Tari, 2015b). demonstrates the decomposition of water using direct current electricity. Since then, the field has evolved significantly, driven by advancements in electrochemical systems, materials science, and catalysis. materials science, and catalysis, (Tari et al., 2022). Modern water splitting can be broadly categorized into three primary methods: electrolysis, photoelectrochemical (PEC) water splitting, and thermochemical water splitting, (Abbas& Bang, 2015). Among these, electrolysis is the most mature and widely researched technique, involving the application of electrical energy to drive the non-spontaneous reaction, (Kannan & Tari, 2025). In a typical electrolyzer, water molecules at the anode are oxidized to form oxygen gas and protons, while at the cathode, these protons are reduced to form hydrogen gas. This process is facilitated by catalysts that lower the activation energy and improve overall efficiency. Photoelectrochemical water splitting, on the other the redox reactions required for splitting water. This method holds promise for direct solar-to-hydrogen conversion, but challenges remain in terms of material stability,

24 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/cost-effective-chalcogenide-based-nanocomposite-electrodes-for-high-performance-electrochemical-and-photoelectrochemical-water-splitting/394125

Related Content

Entropy Generation Minimization in a Vertical Porous Channel

Amel Tayariand Mourad Magherbi (2022). *Advances in the Modelling of Thermodynamic Systems* (pp. 102-112).

www.irma-international.org/chapter/entropy-generation-minimization-in-a-vertical-porous-channel/303383

Impact of Electronic Power Aging on Implantable Antennas: Insights Into Leakage and Current Characteristics of HV Armature Winding

Seeniappan Kaliappan, M. Muthukannan, A. Krishnakumariand S. Socrates (2024). *AI Approaches to Smart and Sustainable Power Systems* (pp. 382-391).

www.irma-international.org/chapter/impact-of-electronic-power-aging-on-implantable-antennas/342927

Eigenvalue Assignments in Multimachine Power Systems using Multi-Objective PSO Algorithm

Yosra Welhazi, Tawfik Guesmiand Hsan Hadj Abdallah (2015). *International Journal of Energy Optimization and Engineering* (pp. 33-48).

www.irma-international.org/article/eigenvalue-assignments-in-multimachine-power-systems-using-multi-objective-pso-algorithm/129120

Future Trends and Opportunities of Waste-to-Energy Innovations Drive in the Tourism Industry

S. Anand Bharathi, S. Vinoth Kumar, S. Rajamohanand D. Unika (2025). *Application of Waste-to-Energy Innovations in Tourism* (pp. 99-140).

www.irma-international.org/chapter/future-trends-and-opportunities-of-waste-to-energy-innovations-drive-in-the-tourism-industry/357588

Chaotic Dynamics and Bifurcations in Impact Systems

Sergey Kryzhevich (2012). *International Journal of Energy Optimization and Engineering* (pp. 15-37).

www.irma-international.org/article/chaotic-dynamics-bifurcations-impact-systems/72728