

# **Exploring the Influence of Solvents on One-Pot Synthesized CdS/MoS<sub>2</sub> Nanocomposites for Sustainable Environmental Remediation and Energy Storage Applications**

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## **Abstract**

The development of nanocomposites with tunable physicochemical properties is essential for tackling global challenges related to sustainable energy storage and environmental remediation. This study comprehensively investigated the impact of several solvents on the structural, textural, and electrical characteristics of MoS<sub>2</sub>/CdS nanocomposites (NCs), as well as their photocatalytic and electrochemical performance. The heterostructured MoS<sub>2</sub>/CdS NCs were synthesized via a one-pot solvothermal approach at 180 °C for 16 h using cadmium acetate dihydrate, sodium molybdate dihydrate, and thiourea as the precursors of Cd, Mo, and S, respectively. X-ray diffraction and N<sub>2</sub> adsorption-desorption analyses confirmed the successful synthesis of the NCs and demonstrated that both crystallinity and BET surface area were strongly influenced by the solvent environment. The photocatalytic performance was evaluated by degrading methyl orange dye under solar irradiation, while electrochemical behavior was assessed for supercapacitor applications. Among the synthesized samples, the MoS<sub>2</sub>/CdS NC obtained using ethylene glycol solvent demonstrated superior photocatalytic efficiency, achieving approximately 99% degradation of methyl orange in just 15 minutes. This efficiency is attributed to its larger surface area and more effective separation of photogenerated charge carriers. Electrochemical measurements further revealed that this sample delivered an enhanced specific capacitance of 445 F/g, outperforming those synthesized with other solvents. This study demonstrates the critical importance of solvent selection in modulating the morphology, surface properties, and

charge-transfer characteristics of CdS/MoS<sub>2</sub> NCs. The findings demonstrate their strong potential as dual-function materials for high-efficiency pollutant degradation and advanced energy storage technologies.

### **Keywords**

CdS/MoS<sub>2</sub> NCs, Photocatalytic Degradation, Supercapacitor, Ethylene Glycol and Solvothermal Synthesis.

### **Biographies**

**Dr. Md. Tamez Uddin** is a Professor of the Department of Chemical Engineering & Polymer Science at Shahjalal University of Science and Technology (SUST), Sylhet, Bangladesh. He obtained his B.Sc. in Chemical Engineering & Polymer Science from SUST in 2002, followed by an Erasmus Mundus M.Sc. in Functionalized Advanced Materials and Engineering from the University of Bordeaux, France, and the University of Augsburg, Germany in 2010. He earned his Ph.D. jointly from the University of Bordeaux and the Technical University of Darmstadt, Germany, focusing on functional materials for energy, information technology, and health. Dr. Uddin's research primarily centers on the development and synthesis of advanced nanomaterials for energy conversion and environmental remediation, including photocatalysis for wastewater treatment, hydrogen generation through water splitting, CO<sub>2</sub> reduction, and the fabrication of semiconductor metal oxide nanoparticles and low-cost adsorbents from biomass. He has led several projects funded by the Ministry of Science & Technology, Ministry of Education, Bangladesh, SUST research centre, on the synthesis of heterostructured photocatalysts and mesoporous activated carbons. Over his career, he has published extensively in high-impact journals, covering areas such as photocatalytic dye degradation, hydrogen evolution reactions, and electrochemical sensors. His work combines fundamental research with practical applications, aiming to address energy and environmental challenges through innovative material design.

**Kaysar Hamid** is a Master's by Research student in the Department of Chemical Engineering and Polymer Science at Shahjalal University of Science and Technology (SUST), where he also completed his B.Sc. degree in Chemical Engineering. He possesses a strong combination of academic research experience and industrial expertise, having worked for almost 2.5 years as a Process Engineer at Petromax Refinery Ltd. His research is focused on advanced photocatalysis and energy materials, with active work on nanocomposites for hydrogen production, environmental remediation, and energy storage. He has authored five conference papers and one journal article published in RSC Advances (Q1), with several additional manuscripts currently under review. He received the prestigious UGC Scholarship for securing the top position in the School of Applied Sciences and Technology, and he was awarded the Best Paper Award at ICERIE-2025. His broader research interests include photocatalysis, energy conversion and storage, biosensor development, nanomaterials engineering, and sustainable process design. Kaysar aims to continue contributing impactful research to the fields of chemical and materials engineering.

**Mustafizur Rahman** is currently pursuing his B.Sc. in the Department of Chemical Engineering and Polymer Science at Shahjalal University of Science and Technology (SUST). He is continuing his undergraduate research on sustainable energy storage systems, focusing on nanotechnology for energy conversion and storage applications, and plans to continue advancing his research in this field in the future.