# Abstract

The thesis entitled "***Synthesis of Organic-Inorganic Nanocomposite Materials and Their Various Applications***" focuses on the synthesis and evaluation of organic-inorganic nanocomposites, specifically Bi and Cu-based metal oxides, to investigate their potential for applications in energy harvesting and environmental remediation. The study explores the distinct electrochemical properties of bimetallic oxides incorporating Bi and Cu with transition metals such as Mo and W.

Utilizing the solvothermal synthesis method, this research endeavors to develop new heterostructured nanomaterials that significantly improve electrochemical performances as well as photoelectrochemical properties. We have systematically investigated various aspects, including surface modifications, embedded defects, optimization of electronic properties, and functionalization of diverse materials. Our approach involves a comprehensive evaluation of these factors to enhance the overall functionality of the nanomaterials. This research explores various nanocomposite systems for energy harvesting and environmental remediation. The findings offer insights into the functionalization and modification of different heterostructured systems.

To comprehensively present the research, the study is organized into five chapters, each addressing distinct aspects of the work.

Here, **Chapter 1** includes a comprehensive literature review of current research and developments that emphasize the potential of Bi and Cu-based metal oxides decorated with organic matrices in addressing the growing need for energy harvesting and effective environmental remediation strategies.

**Chapter 2** details various sophisticated tools, their fundamental principles, and their applications for characterization of nanocomposites.

**Chapter 3** presents the development of a $Bi_2MoO_6/H_2TPP$ nanocomposite electrode for efficient ORR and p-nitrophenol detection, showing high sensitivity and stability.

**Chapter 4** introduces a $\beta$-$Bi_2O_3$-$Bi_2WO_6/H_2TPP$ nanocomposite for selective $Cr^{6+}$ reduction, demonstrating its good sensitivity and environmental remediation potential.

**Chapter 5** reports on $CuWO_4/CuO$ nanocomposite and its rGO blended derivative for HER and OER, respectively, highlighting their impressive performance in water splitting.

The findings indicate that these synthesized organic-inorganic nanocomposites significantly improve fuel cell efficiency, water splitting processes, and environmental remediation. The work offers valuable insights into advancing strategies for energy conversion and environmental remediation.

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24.09.2024

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**Index No.: 100/19/Chem./26**
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24/09/2024.

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