

Preface

Molybdenum diselenide (MoSe_2) is one of the widely studied materials of the transition metal dichalcogenide family, having fascinating properties such as high conductivity, semiconducting characteristics, high surface area, electrocatalytic activity and good stability in acidic/basic medium. These attractive feature characteristics allow MoSe_2 nanostructures to be used in energy generation and storage applications. The present thesis entitled “ **MoSe_2 Nanostructures Based Electrocatalysts for Electrolyzer and Zinc-air Battery**” is focused on the synthesis of pristine MoSe_2 , bimetal oxides- MoSe_2 hybrid nanostructures and Ni decorated MoSe_2 nanocomposites via hydrothermal technique for hydrogen evolution reaction (HER), oxygen evolution reaction (OER), Electrolyzer, and zinc-air battery applications. The morphology and structure of the synthesized samples have been confirmed through Scanning electron microscopy (SEM), Transmission electron microscopy (TEM) and X-ray diffraction (XRD) techniques. We have also performed Raman and Fourier transform infrared (FTIR) spectroscopy techniques to confirm the vibrational characteristics of prepared samples. The X-ray photoelectron spectroscopy (XPS) has been performed to analyze oxidation states of different elements in pristine MoSe_2 , bimetal oxides- MoSe_2 hybrid nanostructures and Ni decorated MoSe_2 nanocomposite. We have further elucidated the electrocatalytic activity of prepared samples through different electrochemical measurements such as cyclic voltammetry (CV), linear sweep voltammetry (LSV), electrochemical impedance spectroscopy (EIS) and chronoamperometry for HER and OER. Further, we have designed electrolyzer and Zinc air battery cells using prepared electrocatalysts and studied their performance.

In-situ grown MoSe_2 over Ni foam (MoSe_2 -Ni foam) electrode shows low overpotential $\eta_{10} \sim 100$ mV and Tafel slope ~ 73 mV dec^{-1} in 1M KOH for HER, while *in-situ* grown MoSe_2 over conducting carbon paper (MoSe_2 -CCP) electrode displays $\eta_{10} \sim 143$ mV and Tafel's slope ~ 53 mV dec^{-1} in 0.5M H_2SO_4 . The better performance of binder-free MoSe_2 -Ni foam and