VINGNANAM Research Conference

21st of July 2022

VRC–2022

Faculty of Science
University of Jaffna
Sri Lanka

Jointly Organized by

Faculty of Science
University of Jaffna
Sri Lanka

Western Norway University of Applied Sciences

The effect of hydrothermal duration on the formation of edge sites of $2-H\ MoS_2$ and the evaluation of hydrogen evolution performances of the material

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Molybdenum disulfide (MoS_2) is a nontoxic, environmentally friendly, abundant semiconducting material which is widely used in the areas of hydrogen storage, gas sensing and solid super lubricants. It has three major phases called $1-T\ MoS_2$, $2-H\ MoS_2$ and $3-R\ MoS_2$. Among them $2-H\ MoS_2$ form is the stable form which has a hexagonal phase structure with an activated edge. Activation of the material is possibly changing by making differences on nature of material edges. In this work, we report the influence of the duration of the hydrothermal process on the growth of edge sites of $2-H$ molybdenum disulphide nanocomposites. We synthesized three $2-H\ MoS_2$ nanostructures by a facile hydrothermal route using ammonium molybdate, thioacetamide and urea as precursors in the deionized water at 200 °C through changing the duration of the hydrothermal process of 24, 36 and 48 hours. Powder X-ray diffraction (PXRD) and scanning electron microscope (SEM) were used to characterize the samples. X-ray diffraction results confirmed that the prepared three products were at the hexagonal phase of MoS_2 without any impurity. The SEM imagers show that the prepared structures have a plate-like structure with sharp edges. Then the linear sweep voltammetry of the materials verified that the high number of sharp edges of MoS_2 nanocomposites lead to excellent activity for hydrogen evaluation reaction (HER). Finally, in comparatively to other two samples clear, sharped and, higher number of edge sites were appeared in the 48 hours sample and a greater number of open edge sites appeared in the 36 hours sample. In conclusion, sharpness and the number of edge sites are possible to control with the duration of the hydrothermal process.

Keywords: *Edge sites, Hydrothermal synthesis, Molybdenum disulfide.*