Microstructural and Electronic Properties of Rapid Thermally Grown MoS_2|Silicon Hetero-Junctions with Various Process Parameters

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Molybdenum disulphide (MoS_2) has gained tremendous attention due to its tunable semiconducting properties and versatile applications in future electronic and optoelectronic devices. Here, MoS_2 thin films were grown by adopting rapid thermal process. The process parameters like time and temperature have been systematically varied to modulate the morphological, microstructural, and electronic properties of MoS_2 thin films. A uniform morphology has been observed from FESEM images. The microstructural study was further carried out using XRD pattern and Raman spectra. The intensity of (002) XRD characteristic peak at $2\theta = 14.1^\circ$ is found to be increased, whereas the FWHM values are reduced with the growth time and process temperature. The improvement of crystallinity of the MoS_2 thin films with growth temperature is attributed to the decrease in the FWHM values of the characteristic Raman peaks, E^1_{2g} and A_{1g}. The dependence of hetero-junction characteristics such as ideality factor η, built-in voltage V_{bi}, and carrier concentration on the growth parameters was evaluated using current–voltage and capacitance–voltage measurements. The films grown at 900°C for 5 min. have possessed carrier concentration of $5.21 \cdot 10^{16}$ cm^{-3}, with 0.55 V as V_{bi}, and η is found to be 2.04 for MoS_2|Si hetero-junction. The decrease in the carrier concentration, η, and V_{bi} in MoS_2|Si hetero-junction with the increase in the growth temperature has been ascribed to the reduction in the defect states due to enhancement in the sulfurization.

Keywords: molybdenum disulphide, rapid thermal processing, sulfurization, hetero-junction.

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