Molecular Beam Epitaxy of $MoSe_2$ Directly on Si

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Van der Waals bonding relaxes the constraints of lattice matching, making two-dimensional (2D) transition metal dichalcogenides attractive in the field of epitaxy. Recently, molecular beam epitaxy (MBE) of $MoSe_2$ has been demonstrated on AlN and GaAs [1,2] but, to our knowledge, the direct growth of $MoSe_2$ on Si by MBE has not yet been reported. Here we investigate the early stages of 2D nucleation of $MoSe_2$ grown on Si by MBE in order to pursue tunable grain size. In principle, large area $MoSe_2$ (0001) will grow on Si (111) with two domain orientations. After removing the oxide by a Piranha etch, Mo and Se are codeposited on Si (111). At constant flux ratios the 2D nucleation rate is controllable with substrate temperature, as confirmed using x-ray diffraction and atomic resolution force microscopy (AFM). Film morphology and structural quality in the high temperature, Mo-limited, regime of $MoSe_2$ growth using high Se vapor overpressures will be discussed.

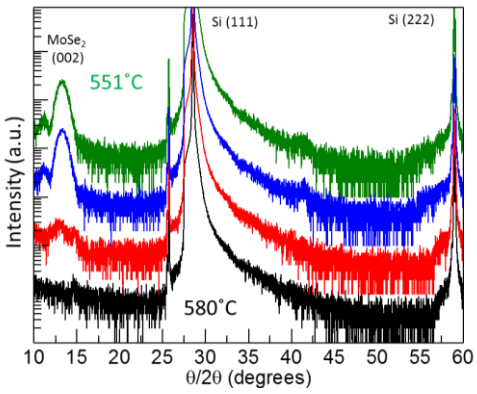

Figure 1: XRD of $MoSe_2$ grown on Si (111) at various temperatures [3].

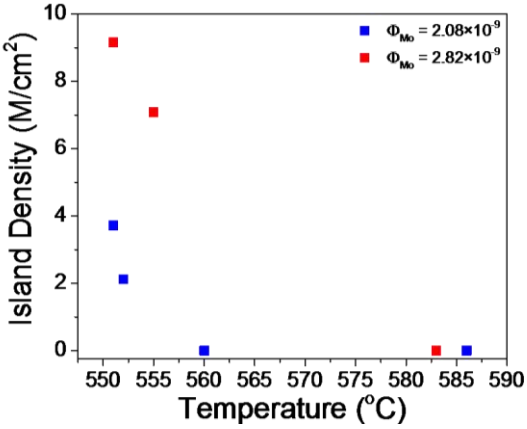

Figure 2: Number of $MoSe_2$ islands measured by AFM as a function of growth temperature and Mo flux

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