Van der Waals solid phase epitaxy to grow large-area manganese-doped $MoSe_2$ few-layers on SiO_2/Si

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Large-area growth of continuous transition metal dichalcogenides (TMDCs) layers is a prerequisite to transfer their exceptional electronic and optical properties into practical devices. It still represents an open issue nowadays. Electric and magnetic doping of TMDC layers to develop basic devices such as p-n junctions or diluted magnetic semiconductors for spintronic applications are also an important field of investigation.

Here, we have developed two different techniques to grow $MoSe_2$ mono and multi-layers on SiO_2/Si substrates over large areas [1].

First, we co-deposited Mo and Se atoms on SiO_2/Si by molecular beam epitaxy in the van der Waals regime to obtain continuous $MoSe_2$ monolayers over 1 cm^2. To grow $MoSe_2$ multilayers, we then used the van der Waals solid phase epitaxy which consists in depositing an amorphous Se/Mo bilayer on top of a co-deposited $MoSe_2$ monolayer which serves as a van der Waals growth tem-plate. By annealing, we obtained continuous $MoSe_2$ multilayers over 1 cm^2. Moreover, by inserting a thin layer of Mn in the stack, we could demonstrate the incorporation of up to 10 % of Mn in $MoSe_2$ bilayers.

Reference

[1] Céline Vergnaud et al 2019 2D Mater. in press.

Figure

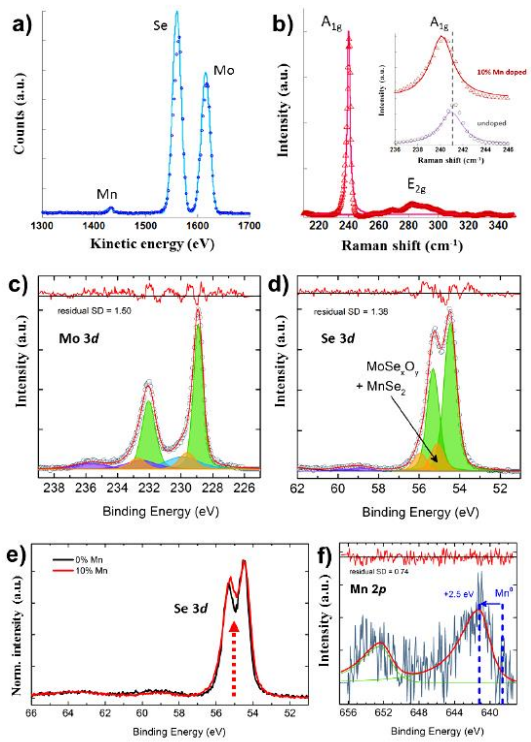

Figure 1: (a), RBS spectrum obtained on the $Mo_{0,91}Mn_{0,09}Se_2$ film grown by vdW-SPE. (b)Typical Raman spectrum obtained on 2 ML of $MoSe_2$ grown by SPE and doped with 10% of Mn on top of 1 ML of $MoSe_2$ grown by co-deposition. (c), and (d), XPS spectra of Mo 3d and Se 3d core levels respectively. (e), Comparison of Se 3d core level XPS spectra with and without Mn. The red dotted arrow points at the emergence of a new peak upon Mn doping at a binding energy close to 55 eV which corresponds to the Mn-Se chemical bond. (f), XPS spectrum of Mn 2p core levels.