Spin-charge interconversion in transition metal diselenides

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Layered Transition metal diselenides (TMD) exhibit a large variety of physical properties ranging from semiconductors ($MoSe_2$, WSe_2), semimetals ($PtSe_2$), metals (VSe_2, $TaSe_2$) and superconductors ($NbSe_2$). More recently, ferromagnetism was also observed in $CrSe_2$ [1]. They possess large spin-orbit coupling and diverse crystalline symmetries (2H, 1T or 1T'). These properties are key ingredients to produce and tailor large spin-orbit torques (SOT) into an adjacent ferromagnetic layer by charge-to-spin conversion. These materials are thus promising candidates for the development of ultra-compact SOT magnetic random access memories (SOT-MRAMs) or all van der Waals SOT-MRAMs.
Until now, the spin-charge interconversion studies were performed on flakes (1-10 µm) of TMDs [2]. In this presentation, we focus on large area (1 cm^2), high crystalline quality TMDs (WSe_2, $PtSe_2$, VSe_2, $NbSe_2$ and their alloys) grown by molecular beam epitaxy (MBE) in the van der Waals regime (see Fig. 1a-c) [3]. We are primarily interested in studying spin-to-charge conversion in these materials by inverse spin Hall or Rashba Edelstein effects. For this, we use the spin pumping-ferromagnetic resonance (SP-FMR) technique sketched in Fig. 1d [4]. The excitation of the FMR of CoFeB grown in situ (without breaking the vacuum) on the TMD generates a spin current converted into a charge current in the TMD. We aim at investigating the influence of the thickness and symmetries of the TMD on the conversion. Our preliminary results show efficient spin-to-charge conversion in $W_{0.9}V_{0.1}Se_2$ (2D metallic alloy) and $NbSe_2$ whereas it is absent in $PtSe_2$ and VSe_2. We will discuss our first conclusions considering the spin-orbit coupling and crystal symmetries.

References

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Figures

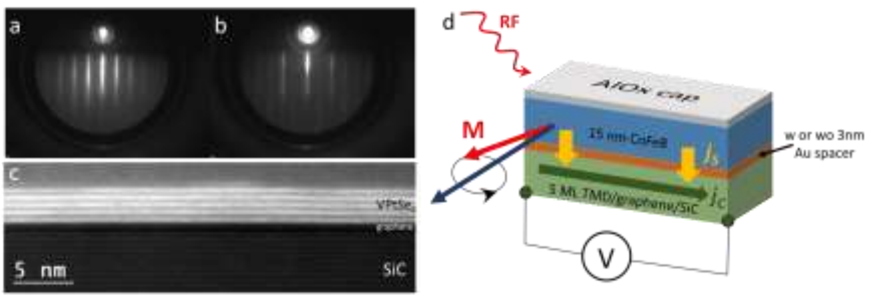

Figure 1: a and **b**, Electron diffraction (RHEED) patterns of 5 ML of $PtSe_2$ epitaxially grown on graphene/SiC along two different azimuths separated by 30°. The anisotropic character shows the single crystalline character of the film. **c**, cross-section scanning transmission electron microscopy image showing 5 ML of $V_{0.65}Pt_{0.35}Se_2$ epitaxially grown on graphene/SiC. **d**, sketch of the SP-FMR technique.