Bound states induced by charged V dopants in monolayer WSe_2

Jean-Yves Veuillen
Florian Chiapello, Hanako Okuno†, Hervé Boukari, Matthieu Jamet†, Pierre Mallet
Institut Néel, CNRS and Université Grenoble Alpes, 38000 Grenoble, France
† IRIG, CEA and Université Grenoble Alpes, 38000 Grenoble, France
jean-yves.veuillen@neel.cnrs.fr

Besides exfolation of bulk van Waals crystals [1], substitutional doping of two-dimensional (2D) semiconductors of the family 1H-MX_2 (M=Mo or W, X=S or Se) by 3d metal atoms is an appealing approach to prepare 2D magnetic layers [2] at the wafer scale using thin films growth techniques. Recent reports indicate that V doped WSe_2 could indeed be ferromagnetic up to room temperature [3, 4]. We present here the analysis by STM/STS of the electronic structure of V doped WSe_2 samples grown by MBE on graphitized SiC surfaces. Individual V dopants show up as large circular structures with a strong electronic contrast (Fig. 1 a-b), which together with the observation of a local upwards band bending [5] demonstrates that the dopants are negatively charged. The associated electronic potential induces one bound state (in-gap sate) at the dopant site (Fig. 1 c) [6]. In line with this "electrostatic" picture, more strongly bound states appear for closely spaced V atoms [6]. Charging is due to the band offset at the graphene/WSe_2 interface and to the acceptor character of V atoms [6]. Eventually, the excess charge would suppress the magnetic moment on the V atoms [7].

References

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Figures

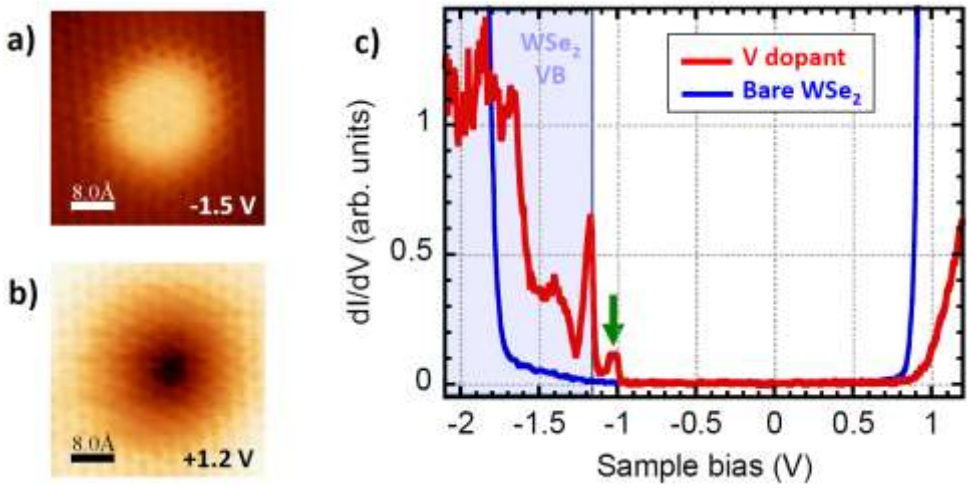

Figure 1: Electronic structure of isolated V dopants in monolayer WSe_2. a) and b) Constant current images of one dopant at negative (a) and positive (b) sample bias. c) Spectra taken at the site of a V dopant (red curve) and on a nearby bare WSe_2 spot (blue curve). The shaded area highlights the energy range of the valence band (VB) states of bare WSe_2. The green arrow points to the bound state systematically found at the V site, with 140 meV binding energy. From [6].