chem2Dmat
August 31 - September 03, 2021 • Bologna, Italy
European Conference on Chemistry of Two-Dimensional Materials

Tuning superconductivity in large-area $NbSe_2$ monolayers via molecular functionalization

M. Gobbi[1,2,3], F. Calavalle[1], P. Dreher[4], A. P. Surdendran[5], W. Wan[4], M. Timpel[6], R. Verucchi[6], C. Rogero[2], T. Bauch[5], F. Lombardi[5], F. Casanova[1,3], M. V. Nardi[6], M. M. Ugeda[3,4], L. E. Hueso[1,3]

[1]CIC nanoGUNE BRTA, 20018 Donostia-San Sebastian, Spain
[2]Materials Physics Center CSIC-UPV/EHU, 20018 Donostia-San Sebastian, Spain
[3] IKERBASQUE, Basque Foundation for Science, 48013 Bilbao, Spain
[4]Donostia International Physics Center DIPC, 20018 Donostia-San Sebastian, Spain
[5]Chalmers University of Technology, SE-41296 Göteborg, Sweden
[6]Institute of Materials for Electronics and Magnetism, IMEM-CNR, IT-38123 Trento, Italy
m.gobbi@nanogune.eu

The ultrahigh surface sensitivity of 2D Materials makes it possible to tune their intrinsic electronic properties through molecular functionalization [1]. While several studies have reported how molecules can be used as dopants to improve the performance of optoelectronic devices based on 2D Materials [2], their impact on other intrinsic physical properties of TMDs, such as superconductivity, remains largely unexplored. Here, we manipulate the critical temperature (T_C) of large-area monolayer $NbSe_2$ in a deterministic way employing ultra-thin self-assembled adlayers [3]. Functionalization with a fluorinated or an amine-containing molecule results in a 55% increase and a 70% decrease in the T_C of $NbSe_2$ monolayers, respectively (Figure 1). Spectroscopic evidence indicates that the recorded changes in T_C are related to electric fields generated by the molecular adlayers, which act as an effective fixed gate terminal. Importantly, the polarity of the field-effect is programmable, as it is determined by an accurate choice of appropriate functional groups. The reported functionalization is efficient, practical, up-scalable and perfectly suited to functionalize TMDs extending over large areas.

References

[1] M. Gobbi *et al.*, Adv. Mater., 18 (2018) 1706103.
[2] M.-A. Stoeckel, M. Gobbi *et al.*, ACS Nano 13 (2019) 11613
[3] F. Calavalle *et al.*, Nano Letters 21 (2021) 136

Figures

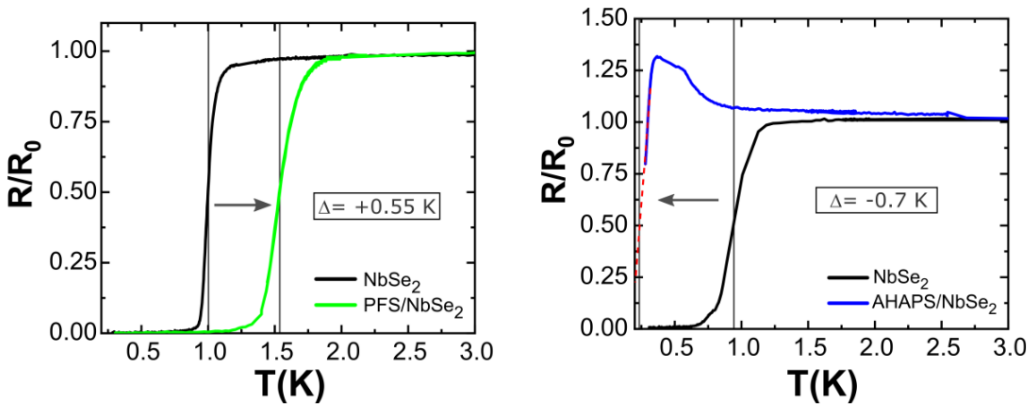

Figure 1: The critical temperature of $NbSe_2$ single layers increases after functionalization with a self-assembled adlayer of Trichloro(1H,1H,2H,2H-perfluorooctyl)silane (PFS), while it decreases after functionalization with a self-assembled adlayer of N-[3-(trimethoxysilyl)propyl]ethylenediamine (AHAPS).