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Defects and doping in phosphorene

Most two-dimensional materials are unintentionally doped, due to the growth process or as a result of the interaction with the atmosphere or with other device components.
Phosphorene is known to be normally p-type, nevertheless it can be used as a channel material for ambipolar field effect transistors able to operate both in the n- and p-type regimes. In this talk, we analyze how tin and single vacancies can contribute to the p-type conductivity in phosphorene. The first is usually left as spurious contaminant in black phosphorus grown by low pressure routes. It is a shallow acceptor defect. The latter is a negative-U defect with charge-dependent structure and is also normally negatively charged.
In addition, exposure to oxygen has been correlated with the increase of the hole density. However, due to the numerous defect reactions that lead to the formation of phosphorene oxide, little is still known about how this can be controlled. In this talk, we will consider the different stages of interaction with oxygen and how oxygen defects can be stabilized, deactivated and compensated.

References

[1] Carvalho, A., Wang, M., Zhu, X., Rodin, A. S., Su, H., & Neto, A. H. C. Phosphorene: from theory to applications. *Nature Reviews Materials*, *1*, 16061 (2016).

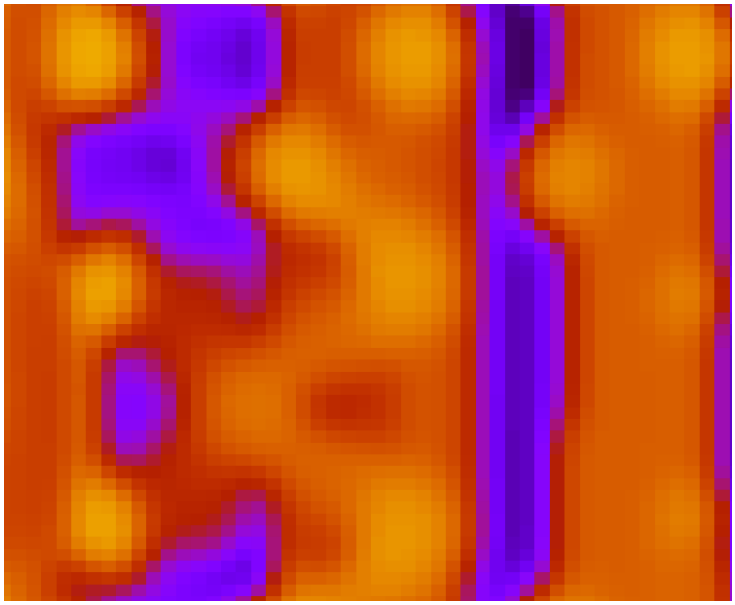

Figure 1: Simulation of a scanning-tunneling microscopy image of a negatively charged vacancy in phosphorene.