Electronic interaction between organic molecules and nitrogen-doped graphene

Van Dong Pham,[1] Vincent Repaint[1], Cyril Chacon[1], Amandine Bellec[1], Yann Girard[1], Jerome Lagoute[1], Sylvie Rousset[1]

[1] Laboratoire Matériaux et Phénomènes Quantiques (MPQ), University Paris Diderot,
10 rue Alice Domon et Léonie Duquet, 75013 Paris, France
van-dong.pham@univ-paris-diderot.fr

Abstract

Interaction between donor and acceptor molecules with graphene is key strategy for tuning and exploiting unique properties of graphene in coupling with the unique properties of molecular building block in molecular electronics. Scanning tunneling microscopy/spectroscopy (STM/STS) offers unique surface investigation technique that provide both topography and electronic properties at atomic spatial resolution of the interacting systems. Here we show the electronic interaction between porphyrins – a donor molecule and another acceptor molecule adsorbed on both pristine and nitrogen-doped graphene. We focus on the electronic interaction between these molecules with graphene, particularly, on nitrogen defect site of doped graphene. The STM results show that on graphene, these molecules form self-assembled molecular island. Strikingly, the molecules adsorbed above nitrogen doping sites are distinctively different (as bright molecules in Figure 1) as compared to those adsorbed on bare graphene area. This effect is originated from a charge transfer that is locally different at nitrogen doping site more than the bare graphene area. As a consequence, the STS taken on these bright molecules revealed a downshift of HOMO-LUMO gap. Then, tip manipulation was used to remove the molecular self-assembly, that finally discovered the underlying nitrogen dopants in order to determine their relative position to the molecules with atomic precision. Our current results offer a basic understanding of the electronic interaction between different types of molecule (donor and acceptor) with graphene, particularly with atomic defect site on graphene (nitrogen doping). This work help better understand on the future fabrication of graphene-related electronic devices, for example, graphene sensor.

References

[1] Pham VD., Lagoute J., Mouhoub O., Repain V., Chacon C., Bellec A., Girard Y., Rousset S., ACS Nano, 8 (2014) 9403-9409.

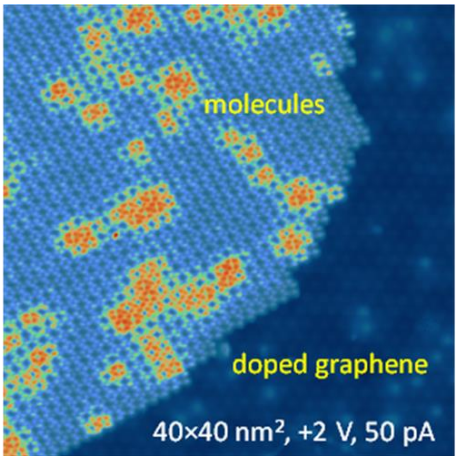

Figure 1: STM image of self-assembled porphyrin molecules adsorbed on nitrogen-doped graphene. The bright molecules are sitting above the nitrogen dopants and induced by a charge transfer from nitrogen sites toward molecules [1].