Spatial mapping of potassium diffusion and intercalation in few-layer graphene studied by ultra-high vacuum spectroscopies

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The isolation of graphene in 2004 sparkled a revolution in material science and nanoscience. High quality crystalline graphene can be mechanically exfoliated from graphite and further studied with many experimental techniques. Alkali metals (AM) can form stable bonds with graphene acting as donors, in a similar fashion to what happens in graphite [1]. Nevertheless, due to the lack of multiple layers in graphene, only adsorption of AMs can take place in such a material and no intercalation is possible, contrarily to what happens to graphite. An intermediate system which is interesting to study both AMs intercalation and adsorption is few-layer (FL) graphene. In this model system the structural simplicity and the possibility of fabricating high-quality single crystals with areas as large as hundreds of μm^2 are key to studying the AM dynamics. In this presentation I will focus on the evaporation in ultra-high vacuum (UHV) of potassium onto four layer (4L) and multi-layer (ML) graphene deposited on SiO_2/Si. I will discuss the diffusion of potassium in the graphene flake at different stages of evaporation using spatially resolved Raman spectroscopy from the first stages until reaching a coverage of KC_{24}. The diffusion of potassium in FL and ML graphene is not trivial, due to the existence of energy barriers for the potassium atoms diffusion, especially when intercalating, and the mutual interaction between potassium atoms. Also the interplay between Bernal AB stacking and AA stacking in FL and ML graphene plays an important role in the process. Thanks to Raman spectroscopy we can disentangle the effects of strain, charging and the collective dynamics of potassium intercalants.

References

[1] Marchiani, D. et al. Nano Letters, (2023), 170-176.