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Nanoscale Infrared Characterisation of Functional Groups on Two-dimensional Materials

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Functionalisation and chemical characterisation of two-dimensional materials (2DMs), such as graphene, often relies on bulk analytical techniques: elemental analysis, FTIR and XPS being common examples. These techniques, combined with topological measurements by AFM, allow for indirect elucidation of chemical structure. Conventional Raman spectroscopy, ubiquitously used when analysing graphene, has a lateral resolution of >500 nm and often can only give detailed information pertaining to polarisable bonding.

With enhancement techniques previously applied to self-assembled monolayers, AFM-IR imaging has been shown to reach resolutions between 10-100 nm at few nanometer thicknesses [1], but this technique has only recently been applied to 2DMs. Analysing an rGO system noncovalently functionalized with pyrene-based molecules, we will show that Raman mapping is not able to distinguish between the different chemical functional groups present on the basal plane. By applying nanoscale IR analysis, a spectrum of each surface can be found which are directly correlated to the bulk FTIR spectrum of the pyrene molecules at 1.6 nm thicknesses. Further, by mapping the flake at responsive wavelengths, we can report chemical imaging for this system at up to 25 nm lateral resolution [2].

We will then go on to present the current advances in this analysis related to 2DMs, not just graphene, and the contributions that this is making in the field of both 2D functionalisation and characterisation.

References

[1] F. Lu, M. Jin and M. a. Belkin, Nat. Photonics, 8 (2014), 307–312
[2] C. Bartlam et al., Carbon N. Y. 139 (2018), 317–324

Figures

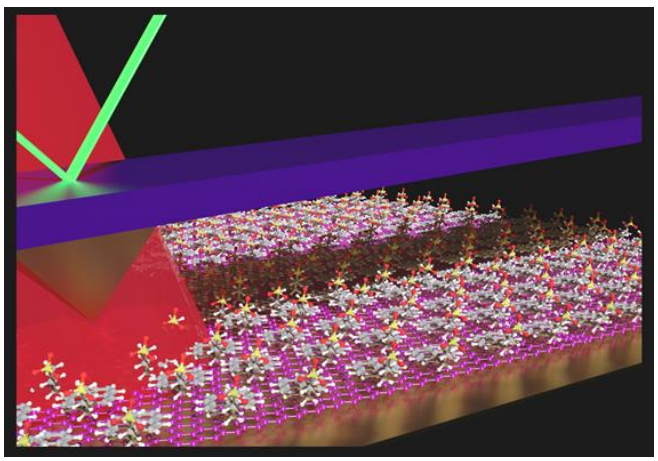

Figure 1: Graphical representation of AFM-IR imaging of a pyrene-functionalised graphene surface.