Functionalisation and hybrids of graphene: tuning the properties and interactions with high-intensity laser

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Even 20 years after its initial discovery, graphene continues to expand its areas of application. To fully utilize all the amazing properties of graphene in different fields, its functionalization was necessary. This poses quite a significant challenge. To enhance the reactivity of graphene, several approaches have been investigated: intentional but controllable creation of wrinkles [1] or changing the doping level [2].
We have demonstrated that the density of wrinkles in CVD-grown SLG on a SiO_2/Si substrate can be controlled by decorating the underlying substrate with uniform nanoparticles (NP). We selected two different protocols of gas phase functionalization: hydrogenation via annealing in a H_2 atmosphere and fluorination via reaction with XeF_2 (Figure 1). Raman spectroscopy, AFM and XPS revealed unambiguously that the level of functionalization increases proportionally with the number of NPs, which means an increasing number of the locally strained SLG. Our approach thus enables control of the amount and the position of functional groups on graphene with nanometer resolution.
We have demonstrated periodic modulation of graphene doping by patterning the substrate with LIPSS investigated by the means of confocal Raman spectroscopy AFM. Parameters of the laser treatment dictate the LIPSS morphology which allowed us to discern the effect of graphene topography and the doping distribution and exploit the latter in chemical functionalization of graphene. Our protocol allowed us to prepare periodic patterns of functional group density on graphene with periodicity given by the underlying LIPSS. These findings, possibly transferrable to other 2D materials, allow to design anisotropic, periodically modified surfaces for advanced applications in (opto)electronics, smart coatings or cell biology experiments.
Currently, in our laboratory, we investigate graphene layers and its hybrids with other nanostructures [3] as the target for the interaction with the high-intensity laser (intensities of 10^{23} W/cm^2).

References

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Figures

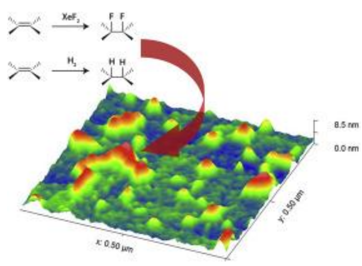

Figure 1: Hydrogenation and fluorination of the intentionally curved graphene –AFM measurements.