Electron-irradiated graphene – properties and applications

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2D materials have established as optimal platform for applications in electronics, optoelectronics and optics both in classical and quantum regime thanks to their remarkable electrical and optical properties. Usually, pristine materials, i.e. with their perfect crystal, are preferred, as lattice defects are generally considered as detrimental for many of its exceptional properties. Nevertheless, when artificially created in a well-controlled manner, defects have a beneficial impact. Indeed, when deterministically created, chemical, thermal, optical, electronic, and mechanical properties are tuned or even newly created in case they are not naturally present [1]. Hence, devices with novel functionalities can be conceive and realized, for example for sensing and nanoelectronics applications.
Here, we present an excursus on our studies on the physical and chemical properties of low-energy electron-irradiated graphene sheets. In particular, these studies aim to shine the light and comprehensively understand the crucial points of the irradiation process in the realm of defective graphene applications. To this end, we firstly describe our experimental and molecular dynamics simulations results on the temporal stability of the defect sites [2], as it defines the operability time scale when dealing with device physics. Subsequently, we explain the role of the supporting substrate both on the disorder density and on the lateral resolution of the defective pattern [3]. Furthermore, we present the lateral resolution limit and the cross talk among defective nanostripes, when periodically repeated on the graphene surface [4]. This kind of structure can find applications, for example, in graphene plasmonics, coherent charge carrier transport or in thermal transport. Finally, we present our results on the chemical functionalization of patterned defective graphene [5]. These results open the route for producing complex sensing circuits, where multiple sensing areas can be arranged in ordered way. Potentially, these areas can also simultaneously sense different chemical species or photon energy if differently functionalized.

References

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Figures

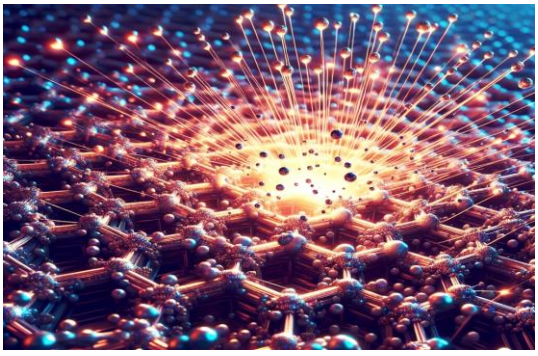

Figure 1: Graphical representation of electron-irradiation of graphene sheet.