High-k substrate effect on the thermal doping of graphene by oxygen

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Graphene (Gr) is the 2D C-based material of wide interest for many applications like microelectronics, materials science and engineering. This large attractiveness arises in part from the peculiar mechanical strength, ambipolar transport, low dimensionality and large surface area. The physical features of Gr may somehow be adapted by its interaction with nearby molecules and nanostructures. In this context, it has been observed that a controlled change of charge carries concentration, or doping, can be achieved through thermal treatments in controlled atmosphere at relatively low temperatures below 400 °C. This feature particularly pertains to Gr transferred on a substrate, but the detailed process is still under investigation to better manage it for applicative aims.

In this study, the thermally induced p-doping process by O_2 molecules adsorbed between Gr and substrates, that are of interest for microelectronics, is deepened. In particular, three different oxides: SiO_2, Al_2O_3, and HfO_2 on Si substrate are considered as well as a surface modified SiO_2. Different characterization techniques were used to determine the morphological, chemical and electronic properties of the substrate and of the Gr. By investigating the role of temperature and time, a diffusion-limited kinetics is found, with strong influence of the substrate in tuning the temperature distribution of Gr-substrate reaction sites, and a prominent role of substrate water affinity is revealed.