**Intercalating graphene on Ir(111)**

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**Abstract**
Epitaxial graphene can be grown routinely and with high crystalline quality on transition metal surfaces such as Ir(111) [1]. However, in order to access the extraordinary electronic properties of the graphene itself, it is necessary to either transfer the graphene to an insulating substrate or to decouple it from the metal surface after growth [2-3]. Intercalation of atomic or molecular species has shown promising results towards both strategies, as the decoupling from the metal surface in some cases is large enough to enable peeling of graphene flakes from its substrate [4]. Furthermore, intercalation is a flexible way of controlling the doping level in the graphene.
Using a combination of angle-resolved photoemission spectroscopy (ARPES), scanning tunneling microscopy (STM) and density functional theory (DFT) we investigate graphene on Ir(111) intercalated by oxygen, which is electronically similar to p-doped freestanding graphene. From a second intercalation step of rubidium atoms we counter-dope the graphene with electrons, see Figure 1. This approach leads to coexisting domains of p- and n-doped graphene on the surface. The resulting intercalation structures, see Figure 2, are characterized by DFT calculations, obtaining doping levels in good agreement with the experiments.
Theoretically, we further extend our studies to a range of other intercalation structures including CO, H, alkali and halogen atoms.

**References**
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**Figures**

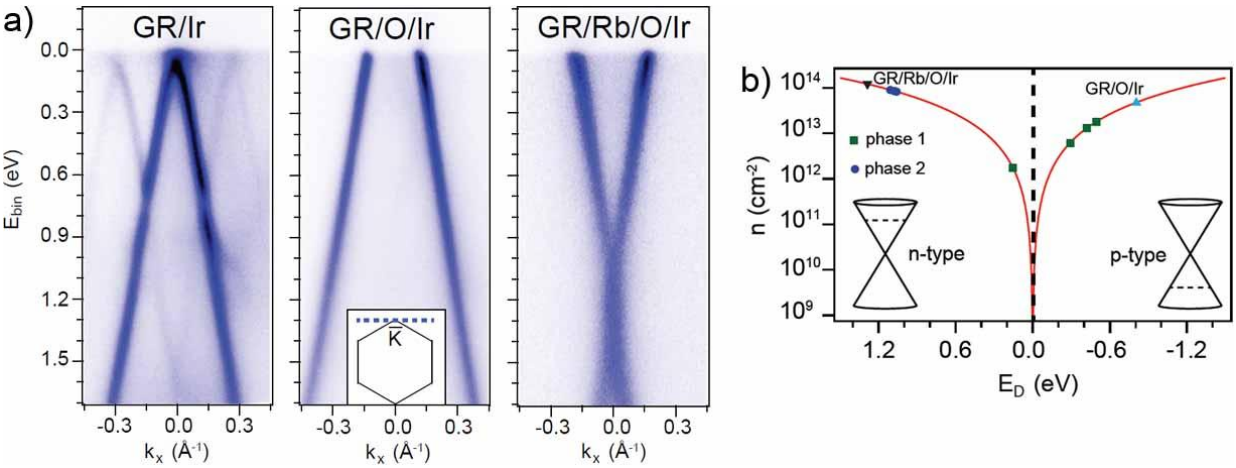


Figure 1: a) High resolution ARPES data of graphene on Ir(111) (GR/Ir), the O-intercalated structure (GR/O/Ir) and the mixed O/Rb-intercalated structure (GR/Rb/O/Ir). b) Doping chart of the transition from p-doped GR/O/Ir to n-doped GR/Rb/O/Ir via two separate doping phases.

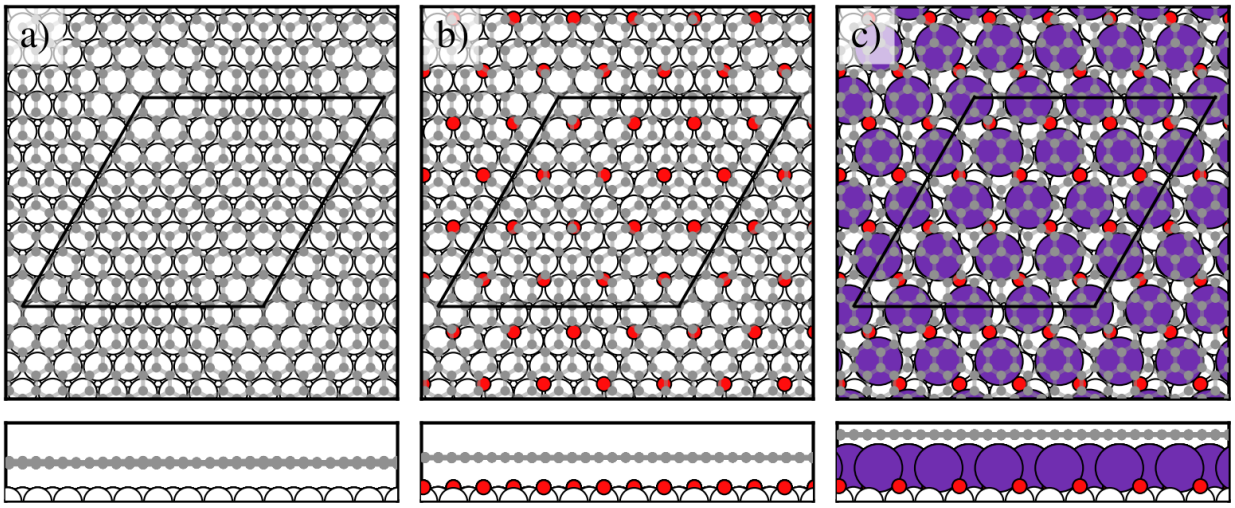


Figure 2: Structures (top view and side view) of a) graphene on Ir(111), b) the O-intercalated structure and c) the mixed O/Rb-intercalated structure.