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Epitaxial Graphene on SiC(0001): Growth and Atomic Intercalation

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Epitaxial graphene grown on silicon carbide (SiC) is regarded as a suitable candidate for carbon based electronics. Homogeneous graphene layers can be prepared with atomic thickness definition on a wafer scale. The electronic and structural properties of the graphene layer can be manipulated by functionalizing the graphene/SiC interface on an atomic scale.

Intercalation under the first carbon layer can relieve the covalent bonds of its atoms to the SiC(0001) substrate and manipulate the π-band structure in a large range of aspects. By hydrogen intercalation this interfacial carbon layer can be turned into quasi-free standing monolayer graphene. Ambipolar doping levels can be reached by Ge intercalation depending on the thickness of the Ge buffer layer. *p*- and *n*-doped domains can be prepared in coexistence on the surface leading to *p-n* junctions on a mesoscopic scale, so that ballistic transport and Klein tunneling can be investigated. Intercalation of Cu induces a coincidence superstructure on top of the SiC surface. As a result, a long range periodic (13×13) potential is imposed onto the graphene layer, which leads to a profound modification of its electronic spectrum. Strong doping and the development of mini-Dirac cones are observed.

By Au intercalation a highly ordered graphene/intercalant/substrate system can be generated which leads to significant many-body interactions and a renormalization of the graphene bands. A sharp 2D band structure of its own is resolved for the gold layer. By controlling the intercalation the dielectric environment of the graphene layer can be tuned. Extremely high doping regimes can be reached by the intercalation of Gadolinium. As a result, the Van-Hove singularity of the π-bands at the M-point reaches the Fermi level. Thus, the intercalation's influence on the electronic structure of the graphene can be viewed as a topological transition from two electron pockets to one hole pocket. The doping is accompanied by a strong bending of the bands in the vicinity of the Fermi energy, which is attributed to electron-electron interaction. Additionally strong electron-phonon coupling is observed. We speculate that the high density of states at the Fermi level may potentially allow to access superconductivity in graphene.