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Giant Rashba effect and spin polarization of Dirac fermions in graphene[1]

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Graphene in spintronics has so far meant a material with low spin-orbit coupling which could be used as high-performance spin current leads. If the spin-orbit interaction could be enhanced by an external effect, the material could serve also as an active element in a spintronics device such as the Das-Datta spin field effect transistors. We show that by intercalation of Au under graphene grown on Ni(111), a Rashba-type spin-orbit splitting of $\sim$ 100 meV can be created in a wide energy range while the Dirac cone is preserved and becomes slightly p-doped. We discuss different superstructures of Au under the graphene which are observed in the experiment. Ab initio calculations indicate that a sharp graphene-Au interface at the equilibrium distance accounts for only $\sim$ 10meV spin-orbit splitting and enhancement can occur due to Au atoms in the hollow position that get closer to graphene while preserving the sublattice symmetry. For the system graphene/Ir(111) we observe a large splitting of the Dirac cone as well. The large lattice mismatch of this system allows us to investigate properties of the pseudospin that are related to the structure of minigaps that occur at the zone boundary of the superstructure. We also report on the giant Rashba splitting of an Ir(111) surface state which persists underneath the graphene. Finally, we re-investigate with p(1×1) graphene/Ni(111) and Co(0001) typical examples where the sublattice symmetry breaking by the substrate is believed to lead to a large band gap at the Dirac point. We show that this is not the case and the Dirac point of graphene stays instead intact, and we discuss implications of this finding.

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