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Rotated graphene bilayers : from independent layers to electronic localization

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Graphene outstanding electronic properties rely on its pristine honeycomb lattice. Interaction with the environment - substrate, other C layers- and how it affects graphene properties will form the guiding line of the talk. While some interactions might degrade graphene properties, others can open new and interesting possibilities. We focus first on graphene on SiC. The atomic and electronic structures of the interface and of the first C-layers will be discussed on the basis of ab initio calculations (VASP) and STM experiments. At variance with the Si face, the interaction with the substrate is weak on the C face so that the first C-layer already presents graphene properties. We propose a model for the interface which explains the observed rotational disorder. We then discuss the effect of a rotation between two graphene layers to show how it can lead to an effective decoupling of these layers and a linear graphene like dispersion. To tackle very small rotation angles, we developed a tight binding scheme based on ab initio calculations. Three regimes can be defined as a function of the rotation angle. In the first one ($\theta > 15^\circ$) the two layers are decoupled and behave like independent graphene layers. In the second one ($1^\circ < \theta < 15^\circ$) the Dirac velocity of the bilayer is renormalised with respect to the velocity of a monolayer while in the last one ($\theta \sim 1^\circ$ or smaller) the velocity drops to zero which results in localisation. These three regimes will be discussed in the light of analytical developments. Experimental evidence or discrepancies with these three regimes will be given.