Dual electronic behaviour effects in triangular nanostructures of graphene bilayers on SiC

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Structural and electronical properties of bilayer graphene films obtained through the sublimation of SiC(0001) were investigated in this work using scanning tunneling microscopy and spectroscopy (STM/STS). Initial graphene samples were obtained by graphitization of a SiC substrate followed by hydrogen intercalation, resulting in quasi-free-standing bilayer graphene. We report on the observation of triangular nanostructures, forming downward and upward steps which we named nanoholes and nanoplateaus, respectively. Our study revealed that the triangular nanostructures result from extended stacking faults on the SiC substrate. This type of extended defect generates regions of high and low atomic density, which influences the surface dynamics during the growth process and creates the observed nanostructures. Spectroscopy measurements also revealed different types of nanostructures, with distinct electronic responses. In particular, it was observed that inside triangular nanostructures the electronic response can range from bilayer graphene to monolayer graphene behavior, undergoing intermediate states whenever the hydrogen intercalation is not complete. Topographic scanning tunneling microscopy images for different tip voltages have also revealed an asymmetric distribution of \( sp^3 \) and \( sp^2 \) bonds inside triangular holes. Using first-principle calculations and assuming a full to partial hydrogen intercalation condition we have modeled the band structure of these objects near the Fermi level. We conclude that it is possible to tune the electronic states of these nanotriangles to prepare the behaviour of the nanostructure [1].


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