Growth, Intercalation and Tunnel Spectroscopy of Cobalt Nanodots Bellow Graphene on SiC(0001)

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The intercalation of cobalt between a graphene layer and the buffer layer on SiC(0001) leads to three different situations depending on the local atomic concentration: isolated atoms [1], clusters of a few atoms [2][3] and nanodots (see figure). STM images shows, on the one hand, that the clusters have a very narrow size distribution and a single atomic height and, on the other hand, that the nanodots have sizes of a few tens of nm and heights compatible with one to three cobalt planes covered by one graphene plane as evidenced on the figure by two typical "flower" defects of graphene [4]. These nanodots present moirés whose non-hexagonal symmetry is currently not understood. Spectroscopic measurements of conductance and work functions, see figure, confirm that graphene is n-doped without cobalt [5] and that it loses its doping progressively for an intercalation of isolated atoms to a quasi-neutrality for the nanodots, cobalt acting as a p-dopant. Correlatively, the work function increases from 4.25 eV for a cobalt-free graphene monolayer, a value comparable to that measured by ARPES [6], to 4.6 eV on the nanodots. The study of Image Potential States by STS shows that the asymmetry of the two first peaks seen on graphene is absent on nanodots. DFT calculations of the band structures of graphene multilayers on SiC confirm the opening of a gap at the K-point in the solid states for graphene bilayers and trilayers, which allows to compare the calculated densities of states with the experimental results and, although indirectly, to allow a more accurate interpretation of those results.

References

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Figure

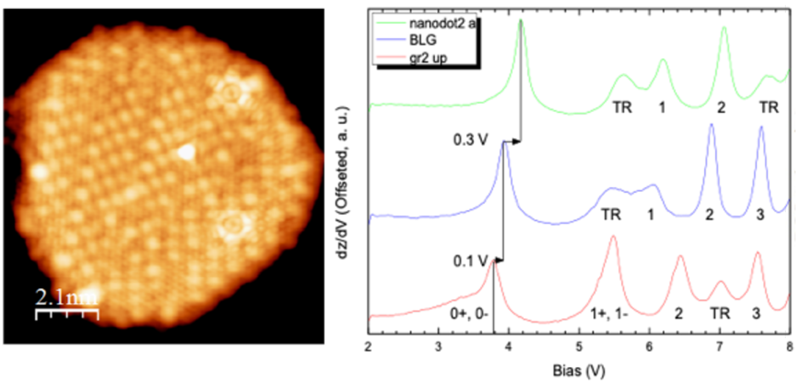

Figure : STM image of a 2D cobalt nanodot intercalated between a monolayer graphene and a buffer layer on SiC(0001). Spectroscopy of image potentials surface states revels a Co p-doping effect.