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Manipulate the Doping of Graphene at Nanoscale with Intercalated Oxygen XIN ZHANG, HONG LUO, Department of Physics, University at Buffalo, the State University of New York, LEI LIU, GONG GU, Department of Electrical Engineering and Computer Science, the University of Tennessee, DANIELE STRADI, MADS BRANDBYGE, Department of Micro- and Nanotechnology, Center for Nanostructured Graphene, Technical University of Denmark — We have created nanoscale p- and n-doped graphene regions side by side, by partially removing the oxygen between the graphene and the Cu foil growth substrate intercalated upon elongated air exposure. The Cu foil surface is almost exclusively (100) oriented, and the removal of intercalated oxygen is by thermal annealing. Scanning tunneling microscopy (STM) reveals a 0.72×0.72 nm square superlattice in the single layer (1L) graphene/O/Cu(100) structure, assigned to be Cu($2\sqrt{2}\times2\sqrt{2}$)R45°-O, which has not been reported so far. Graphene with intercalated oxygen underneath it is p-doped while the surrounding graphene areas, directly in contact with the copper surface, are n-doped. Comparing the scanning tunneling spectra (STS) of the two types of regions, we show a charge transfer-induced shift of the electronic structure. Such a shift is also observed between p- and n-doped twisted bilayer (2L) graphene regions, where the van Hove singularity (vHS) peaks are used as markers to precisely determine the energy shift. Across the boundaries between the p- and n-doped regions, the shift of the electronic structure is spatially resolved, showing the vanishing and reappearance of the vHS peaks. The experimental observations are consistent with first-principles calculations.

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