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Large Physisorption Strain in Graphene Grown by Chemical Vapor Deposition on Copper Substrates¹

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Single layer graphene grown by chemical vapor deposition (CVD) on Cu substrates is subject to non-uniform physisorption strain that is dependent on the orientation of the Cu surface. The blue-shift and broadening of Raman bands of graphene on the Cu single crystal (111) surface reveal that the graphene layer is under compressive strain. This interpretation is consistent with Moire patterns seen in scanning tunneling microscopy. Graphene grown on the Cu (100) surface is subject to a highly non-uniform strain due to the mismatch between the graphene honeycomb lattice and the square lattice at this Cu surface. Molecular Dynamics simulations are in excellent agreement with experiment, predicting compressive strain on the order of 0.5 percent in graphene/Cu(111). In graphene/Cu(100) the simulated physisorption strain patterns show linear superstructures spaced about 1 nm apart and a highly non-uniform bond length distribution which leads to both compressive and tensile strains. CVD graphene grown on polycrystalline Cu foil is also studied for comparison. The strain in graphene is even more non-uniform for growth on Cu foil. However, this strain is greatly reduced after the graphene layer is removed and transferred onto a SiO2 substrate. Physisorption strain is thus revealed to be a major factor in the growth of CVD graphene on transition metals.

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