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Graphene growth on coinage-metal substrates[1]

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The low solubility of carbon in Cu and Au gives these coinage metals advantages as substrates for graphene growth. Namely, growth occurs exclusively by surface processes, avoiding the complications of C segregating from the bulk of the metal substrate. However, the relatively weak interactions of Cu and Au with graphene can lead to mosaic films having large ranges of in-plane orientations. This talk will emphasize understanding the relationship between the microstructure of graphene sheets and the mechanisms of island nucleation and growth. We use low-energy electron microscopy (LEEM) to observe growth. We find that bunches of substrate steps on Cu(111) can generate misorientation boundaries in a graphene sheet as it overgrows the steps [1]. Thus, growth on rough Cu(111) leads to large rotational disorder. Optimized growth on smooth Cu(111) and Au(111), however, produces islands all in close registry to a single in-plane orientation. On Cu(100), the most abundant grain orientation of commercial Cu foils, graphene islands align around two equivalent in-plane Cu directions [2]. This inherent source of disorder from symmetry mismatch is further compounded by large spreads of orientation around the equivalent directions. The substrate choice also affects the microscopic growth mechanism. The rate that C diffuses to the graphene islands limits growth on Cu(111) [and likely on Au(111)]. The sheet edges are then morphologically unstable, with dendritic islands at low temperature and six-fold loped islands at higher temperature. In contrast, growth on Cu(100) is limited by the rate of C attaching to the graphene edge. This mechanism, combined with the symmetry mismatch, produces two-fold islands. Finally, the coinage metals will be compared to other transition metal substrates.

[1] Phys. Rev. B 84, p. 155425 (2011).
[2] Nano Lett. 10, p. 4890 (2010).

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