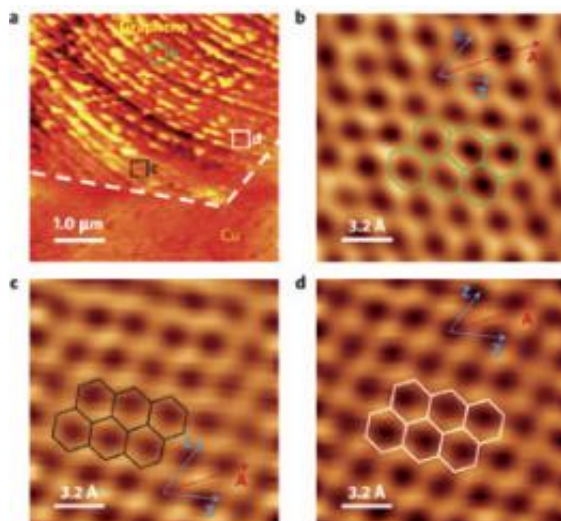


# STM of individual grains in CVD-grown graphene

24 June 2011



The first scanning tunneling microscopy (STM) images of graphene synthesized on copper foil. (b-d) show atomic-resolution images at various locations of the large graphene domain shown in (a).

Users from Purdue University, working collaboratively with staff in the CNM Electronic & Magnetic Materials & Devices Group, studied CVD-grown graphene on polycrystalline copper foil for the first time at the atomic-scale. The ultrahigh vacuum scanning tunneling microscopy (UHV-STM) findings performed at CNM will help to guide the optimization of synthesis towards defect-free graphene.

The focus of this study was to investigate the quality of the films and relative orientations of different [graphene](#) domains using the UHV-STM facility at CNM. The recent paper also addresses the resulting implications for domain boundary effects on transport properties.

The work follows previous studies done at CNM that investigated graphene on single-crystal Cu(111). Similar to the single-crystal work, it was shown that domain boundaries dramatically affect

the carrier mobility of the graphene sheets. The ability to synthesize high-quality graphene for large-scale integration is one of the key challenges for this material system. Fundamental STM experiments performed at the atomic-scale have enabled the study of defects in the as-grown films.

Researchers from the University of Houston, Texas State University, Carl Zeiss SMT, and the Center for Functional Nanomaterials also participated in the study, which is featured as the cover image of *Nature Materials*.

**More information:** Y. Qinkai et al. "Control and characterization of individual grains and grain boundaries in graphene grown by chemical vapour deposition," *Nature Materials*, 10, 443 (2011) [doi:10.1038/nmat3010](https://doi.org/10.1038/nmat3010)

## Abstract

The strong interest in graphene has motivated the scalable production of high-quality graphene and graphene devices. As the large-scale graphene films synthesized so far are typically polycrystalline, it is important to characterize and control grain boundaries, generally believed to degrade graphene quality. Here we study single-crystal graphene grains synthesized by ambient chemical vapour deposition on polycrystalline Cu, and show how individual boundaries between coalescing grains affect graphene's electronic properties. The graphene grains show no definite epitaxial relationship with the Cu substrate, and can cross Cu grain boundaries. The edges of these grains are found to be predominantly parallel to zigzag directions. We show that grain boundaries give a significant Raman 'D' peak, impede electrical transport, and induce prominent weak localization indicative of intervalley scattering in graphene. Finally, we demonstrate an approach using pre-patterned growth seeds to control graphene nucleation, opening a route towards scalable fabrication of single-crystal graphene devices without grain boundaries.

Provided by Argonne National Laboratory

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