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Graphene Under the Tip: Ultra-High Resolution Atomic Force Microscopy Of Chemically Decorated 2D-materials

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Abstract

This past decade has amassed an ignition of expansive interest into the research and application of graphene and other 2D-materials. With a thickness of just one atom, these materials present a myriad of challenges in: fabrication, handling and characterization. The continued emergence of more complex vertical assemblies of 2D-materials, known as Van-der-Waals heterostructures, also opens new avenues of research as well as creates new challenges for the scientific community. One of these challenges is embedding molecular structures into such 2D-materials; effectively, creating a new class of functionals molecules i.e. hybrid organic-inorganic 2D-materials with self-assembled molecular layers. Given the vast libraries of synthetic organic molecules with various tunable functional properties, this creates endless opportunities for the design of new hybrid materials.

Common 2D materials, as well as their new variations, require robust characterization techniques which can analyze both the structure and properties at the highest level. The investigation technique such as Atomic Force Microscopy (AFM) becomes not just a curiosity, but a need to acquire reliable and accurate data. AFM is a technique that can easily image molecular and atomic structures within different environments, at the highest levels of resolution.

During this workshop, Park Systems will present some examples of imaging graphene/hBN heterostructures in the ambient on Park Systems NX20 large sample AFM. We will begin by focusing on resolving and understanding Moiré patterns on graphene (Fig. 1) and show how one can manipulate them with use of an AFM probe. We will then discuss the challenges and breakthroughs in chemical decoration of graphene. In particular, we will demonstrate the imaging of various molecular structures on graphene down to single molecular levels.

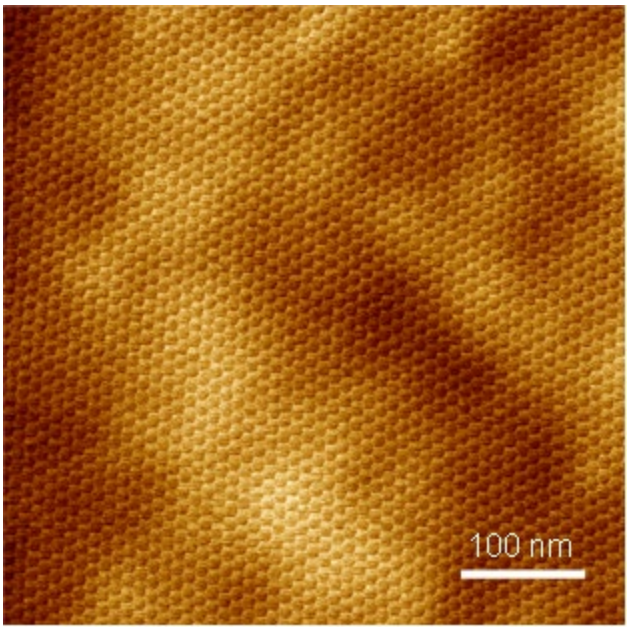

Figure 1. A contact mode AFM image of a Moiré pattern on graphene on a single crystal of hBN, using Park Systems NX20 large sample AFM.

Keywords

2d materials

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AFM