Synthesis & Characterization of Boron Nitride-doped Graphene on Cu(111)

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Abstract oral / poster presentation

With a world population above 8 billion people and a forecast of nearly 10 billion by 2050, humankind demands resources to fulfill the energy requirement. In addition, the requirements to reduce the contamination from fossil fuels used as main source of energy in society nowadays have to be met.[1] Therefore, the European Union aims at reaching two targets by 2030: at least 32% renewable energy and at least 32.5% improvement in energy efficiency.[1]
Two-dimensional (2D) materials play a significant role in the research towards these aims. A wide range of 2D materials have emerged: graphene-based materials, metal dichalcogenides, transition metal carbides/nitrides, layered oxides and hydroxides, layered metal-organic frameworks, and elemental 2D materials, among others.[2] Research of 2D materials has enabled applications ranging from electronics and photonics to energy conversion and catalysis.
Our research focuses on finding a replacement for one of the most common materials in our daily life, silicon (Si). Widely used in electronics and photonics, Si presents numerous limitations. Therefore, we study the process of doping graphene with boron and nitrogen to create a semiconductor that improves the electronic properties of Si and therefore increases the efficiency of future devices significantly.
This new material (BN-doped graphene) is grown under ultra-high vacuum conditions via chemical vapor deposition using ethylene (C_2H_4) and hexamethylborazine ($C_6H_{18}B_3N_3$) as carbon, and boron and nitrogen precursors, respectively. The scanning tunneling microscopy results shown in Figure 1a and b show the atomic structure of graphene-like structures. The black regions indicated with white arrows in Figure 1a show the low segregation of the BN cores within the graphene structure. This is further supported by X-ray photoelectron spectroscopy measurements. Figure 1c shows the C1s core level, confirming the presence of carbon, boron, and nitrogen bonds. To confirm the semiconducting behavior (i.e., the presence of a bandgap), we performed angle-resolved photoelectron spectroscopy (Figure 1d). The characteristic cone of graphene where the valence and conduction band touch disappeared. Instead, a flatter valence band is observed indicating the opening of a small bandgap and therefore confirming the semiconducting behavior of this new material (BN-doped graphene).

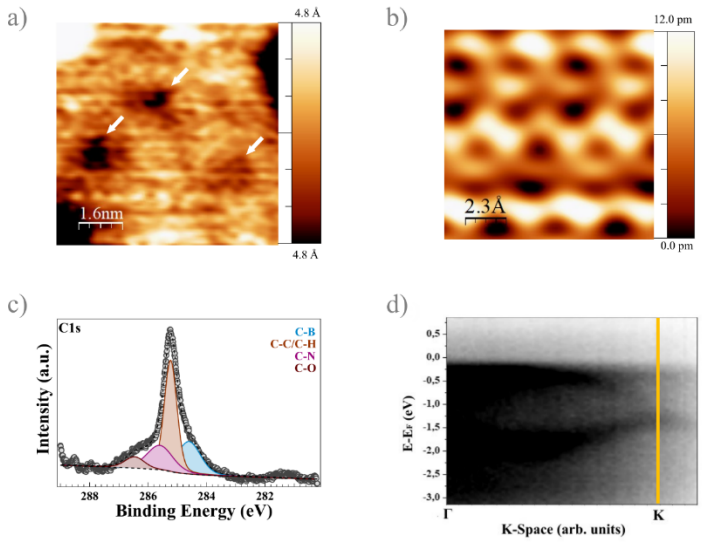

Figure 1. *BN-doped graphene's microscopic and spectroscopic characterization. (a) and (b) Atomically resolved scanning tunnelling microscopy images. BN domains indicated with white arrows. (c) X-ray photoelectron spectroscopy C1s core level characterization at Al Kα energy. (d) Angle-resolved photoelectron spectroscopy cut from Γ to K in reciprocal space. Taken at 55 eV.*

References

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