O 26: Poster Session - Graphene: Growth, Structure and Substrate Interaction

Time: Monday 18:15–20:00 Location: P1A

O 26.1 Mon 18:15 P1A

Investigating the quality of CVD-grown graphene on germanium using in-situ surface science methods — •Andreas Becker, Jarek Dabrowski, Mindaugas Lukosius, and Christian Wenger — IHP, Frankfurt (Oder), Germany

Germanium epitaxially grown on silicon has emerged as a relevant substrate for graphene growth because it is possibly compatible with established CMOS processing. Besides optimizing wafer-scale graphene growth on germanium template and subsequent transfer, we are exploring ways to directly integrate graphene growth into technological processing. However, major challenges are the relatively low quality of graphene on the standard orientation Ge(001) and the high required synthesis temperature. These challenges motivated an investigation of the growth process using a high-pressure preparation chamber for chemical vapor deposition that is connected to a surface science cluster tool. As a prerequisite for reliable graphene growth, we present a detailed study of the germanium substrate pre-cleaning and describe how to avoid etch pit formation. Furthermore, we investigated the influence of growth temperature on quality of graphene on Ge(001), Ge(110) and Ge(111) using scanning tunneling microscopy, low-energy electron diffraction and Raman spectroscopy. We discuss graphene grain size and morphology, epitaxial alignment and intragranular defect density and conclude that the best graphene quality is obtained on Ge(110) at a growth temperature near the substrate melting point. Finally, we intend to bring up a discussion how enhancement of substrate-mediated catalytic etching might help improve the graphene quality.

O 26.2 Mon 18:15 P1A

Reducing the step bunching during the growth of epitaxial graphene on silicon carbide — •Robert Appel, Richard Hönig, Philipp Weinert, and Carsten Westphal — Experimentelle Physik I, TU Dortmund, Otto-Hahn-Strasse 4a, 44227 Dortmund, Germany

Epitaxial graphene (EG) has attracted significant interest in the recent years due to the simple preparation method by heating silicon carbide (0001). One drawback of this approach is step bunching (SB) that leads to large terraces and tall step heights. These tall steps result in anisotropic electronic and magnetic properties of EG. In order to restore the electronic and magnetic properties of graphene, samples with shallow steps are desirable. The $(6\sqrt{3} \times 6\sqrt{3})$R30°-reconstruction (so-called buffer layer (BL)) of the SiC(0001) that forms while heating constrains the SB. Therefore, a fast formation of the BL is of utmost importance.

We use the confinement controlled sublimation (CCS) method in argon atmosphere because it is known for reproducibility and tunability. Thus, it is a promising method to find the ideal parameters for fast BL formation. Kruskopf et al. demonstrated the preparation of EG with shallow steps and less SB by using a high heating rate, a short heating time and a high preparation temperature.

In this study, we explore the applicability of the CCS method in order to obtain similar results with shallow steps and less SB. For this purpose, we systematically modify the preparation parameters and characterize the obtained samples with atomic force microscopy.

O 26.3 Mon 18:15 P1A

LEED and LEEM Study of Hexagonal Boron Nitride Islands and 6x2 Boron Reconstruction on Ir(111) Grown via Thermal Catalytic Decomposition of Borazine ($B_3H_6N_3$) — •Marko Kriegel[1], Karim Omambac[1], Christian Brand[1], Pascal Dreher[1], David Janoschka[1], Ulrich Hagemann[2], Nils Hartmann[2], Frank Meyer zu Heringdorf[1,2], and Michael Horn-von Hoegen[1] — [1]Faculty of Physics and Center for Nanointegration Duisburg-Essen (CENIDE), University of Duisburg-Essen, Lotharstraße 1, 47057 Duisburg, Germany — [2]Interdisciplinary Center for Analytics on the Nanoscale (ICAN) Carl-Benz-Str. 199, 47057 Duisburg, Germany

High quality large area hexagonal boron nitride layers are grown on Ir(111) via thermal catalytic decomposition of borazine ($B_3H_6N_3$) using CVD technique. The preparation of large (6x2) reconstructed 2D boron islands [1] is initiated by the dissolution of boron into the bulk at high temperatures followed by subsequent segregation of boron atoms to the surface upon cooling [2]. The surface morphology and structure determination has been performed in-situ by high-resolution spot profile analyzing-LEED (SPA-LEED), real-time growth observation via low energy electron microscopy (LEEM) and ex-situ by atomic force microscopy (AFM). The chemical composition has been determined ex-situ by X-ray photoemission spectroscopy (XPS) and time-of-flight secondary ion mass spectroscopy (ToF-SIMS) measurements.

[1] Applied Surface Science 420, 504-510 (2017)
[2] ACS Nano 13, 3816-3822 (2019)

O 26.4 Mon 18:15 P1A

Twisted Graphene on Ir(111) and SiC(0001) Studied by SPA-LEED — •Christian Brand[1], Birk Finke[1], Karim M. Omambac[1], Laurenz Kremeyer[1], Frank-J. Meyer zu Heringdorf[1,2], and Michael Horn-von Hoegen[1] — [1]Universität Duisburg-Essen and CENIDE, Germany — [2]ICAN, Duisburg, Germany

When graphene is placed on a crystalline surface, the periodic structures within the layers superimpose and moiré superlattices form. Small lattice rotations between the two materials in contact strongly modify the moiré superlattice, upon which many electronic, vibrational, and chemical properties depend. Here we report on the structural manipulation of epitaxial graphene grown on metallic Ir(111) and semiconducting SiC(0001) surfaces. The spontaneous reorientation in the degree- and sub-degree-range of graphene on Ir(111) depends on the substrate temperature during growth. This effect is described by a 2D coincidence network favored by strain reduction together with the dissimilar thermal expansion of the substrate and graphene. The resulting effective compressive biaxial pressure is more easily accommodated in graphene by small rotations rather than by compression [Nano Lett. **19**, 4594 (2019)]. For graphene on SiC(0001) only the oriented R0° phase is found due to the higher bonding strength to the substrate. Upon H and Sn intercalation this interaction can be reduced such that the graphene layer is lifted from the substrate. Finally, we present a detailed analysis of an unusually broad diffraction background found for graphene and hex-BN on both substrates [Phys. Rev. B **110**, 155307 (2019)].