DS 29: Poster: 2D Materials and their Heterostructures

Time: Wednesday 15:00–18:00 Location: P1A

DS 29.1 Wed 15:00 P1A

On the detection of hydrogenated cyclo[18]carbon by a graphene sheet — •Dominguez Gutierrez Francisco Javier[1], Martinez-Flores Cesar[2], Krstic Predrag[3], and Cabrera-Trujillo Remigio[4] — [1]Max-Planck-Institut für Plasmaphysik, Boltzmannstrasse 2, 85748 Garching, Germany — [2]Departamento de Quimica, Division de Ciencias Basicas e Ingenieria, Universidad Autonoma Metropolitana-Iztapalapa, Mexico City, Mexico — [3]Institute for Advanced Computational Science, Stony Brook University, Stony Brook, NY 11749, USA — [4]Instituto de Ciencias Fisicas, Universidad Nacional Autonoma de Mexico, Cuernavaca, Mexico

In this work, we carry out a theoretical and computational study of the hydrogenated cyclo[18]carbon molecule adsorption by a graphene sheet. We utilize the self-consistent-charge density-functional tight-binding method and the electron-nuclear-dynamics approach to model the hydrogenation of a C18 by atomic and molecular hydrogen irradiation in an impact energy range of 0.5*25 eV. Quantum Classical Molecular dynamics simulations are performed to compute the probability of C18H molecules formation as a function of the impact energy. The carbon ring is previously thermalized to 5 and 300 K, which is deformed by the hydrogen bound after hydrogen irradiation at energies below 5 eV. Cx fragmentation rates cases after collision are also reported. Therefore, we investigate the adsorption rates of pristine and C18H molecules by a graphene sheet at 1 and 2 eV to explore electronic properties of a 2D carbon material.

DS 29.2 Wed 15:00 P1A

Charge signals in non-local spin measurements and how to avoid them — Frank Volmer, •Anne Schmidt, Timo Bisswanger, Christoph Stampfer, and Bernd Beschoten — 2nd Institute of Physics and JARA-FIT, RWTH Aachen University, 52074 Aachen, Germany

For spin-sensitive measurements a non-local device geometry is often used to avoid spurious signals due to the flow of charges. Nevertheless, in the vast majority of reported spin valve and Hanle measurements a background signal is observed which is not related to spins. This is especially true for lock-in based measurement techniques in which a charge signal, which is shifted in phase by 90° in regard to the spin signal, can show amplitudes several orders of magnitude higher than the actual spin signal. We discuss the origin of such charge signals and present a custom-made current source which is able to minimize their effects on spin measurements. By using this current source we are able to increase both the sensitivity and the speed in the measurement of graphene-based spin-valve devices with ferromagnetic Co electrodes and MgO tunnel barriers.

DS 29.3 Wed 15:00 P1A

Spatially resolved Raman spectroscopy of twisted bilayer graphene — •Aaron Johannes Schäpers[1], Robin Joey Dolleman[1], and Christoph Stampfer[1,2] — [1]JARA-FIT and 2nd Institute of Physics, RWTH Aachen University, Germany — [2]Peter Grünberg Institute (PGI-9), Forschungszentrum Jülich, Germany

Twisted bilayer graphene (tBLG) is attracting increasing attention mainly because of the possibility to observe highly interesting many body phenomena such as interaction driven insulating states, ferromagnetism or even superconductivity. All this phenomena depend crucially on the twist angle between the individual graphene layers. Although the overall twist angle can be adjusted when assembling tBLG structures, it is known that the twist angle can vary over the sample and thus making the twist angle homogeneity a key parameter for device quality. In our work, we present spatially resolved confocal Raman spectroscopy measurements as a non-destructive and fast way to provide detailed information about the twist angle homogeneity in artificially made tBLG samples. In particular, we present detailed Raman maps on tBLG samples of 4°, 6° and 8° twist angle, allowing extracting information of the twist angle variation, with the long-term aim to improve this method so that it can be applied for twist angles from 1° to 12°. Moreover, we show some Raman measurements on graphene/hBN heterostructures with different twist angles.

DS 29.4 Wed 15:00 P1A

Tunable spin-orbit coupling in bilayer graphene / WSe2 Heterostructures — •Julia Amann[1], Tobias Völkl[1], Kenji Watanabe[2], Takashi Taniguchi[2], Dieter Weiss[1], and Jonathan Eroms[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg, Germany — [2]NIMS, 1-1 Namiki, Tsukuba, Ibaraki 305-0044, Japan

Heterostructures of graphene and TMDCs are predicted to show strong spin-orbit coupling due to proximity effects. The built-in electric field in bilayer graphene opens an orbital band gap. In addition, applying an external electric field leads to a controllable switching of the spin-orbit splitting.

By van der Waals pickup technique, we fabricated stacks of bilayer graphene and WSe2 on top. We used hBN as an insulator for a Cr/Au topgate. With this dual gated device, it is possible to change the applied transverse electric field and the charge carrier concentration independently. The magnetoconductivity curves show a sharp peak from weak antilocalization as a sign of spin-orbit coupling, which decreases with increasing temperature. Further, we observed a clear dependence of the peak height on the displacement field. This indicates a tunability of the induced spin-orbit coupling.

The peaks were fitted using theory by McCann / Fal'ko, and the resulting spin relaxation times show a giant anisotropy (ratio between the out-of-plane and in-plane time) of ~40. The estimated Rashba- and valley-Zeeman spin-orbit coupling strengths are on the order of 1meV and show a strong dependence on the applied electric field.

DS 29.5 Wed 15:00 P1A

spectroscopy of 2D-metals hosted by epitaxial graphene — •Lassaunière Margaux[1], Nisi Katharina[2], Subramanian Shruti[3], Lambers Hendrik[1], Sigger Florian[2], Tiede David[1], Robinson Joshua[3], and Wurstbauer Ursula[1] — [1]Institute of Physics, University of Münster, Münster, Germany — [2]Walter Schottky Institute and Physics Department, Technical University of Munich, Garching, Germany — [3]Department of Materials Science and Engineering, The Pennsylvania State University, Pennsylvania, USA

Two-dimensional metal films show distinctly different behaviour compared to their three-dimensional cousins. Metals are no van der Waals materials, however, 2D films can be prepared via confinement epitaxy by intercalating metals between epitaxial graphene and the hosting SiC crystal. Here, we explore the fascinating properties of D gallium and indium that include plasmonic resonances and superconducting behaviour by a combination of spectroscopic imaging ellipsometry, scanning probe methods and Raman spectroscopy.

DS 29.6 Wed 15:00 P1A

Impact of disorder and imperfections on the optical properties of TMDCs — •Hendrik Lambers[1], Julian Klein[2], Margaux Lassaunière[1], David O. Tiede[1], Katharina Nisi[2], Alexander Holleitner[2], and Ursula Wurstbauer[1] — [1]Institute of Physics, University of Münster, Münster, Germany — [2]Walter Schottky Institute and Physics Department, Technical University of Munich, Garching, Germany

Interfacial imperfections induced by substrate and environment are known to potentially reduce the electronic and optical properties of semiconducting transition metal dichalcogenides [1]. On the other hand, deterministically induced point defects induced by focused ion beams are promising candidates to serve as quantum emitters with well controlled energies that can be positioned with nm resolution [2]. Here, we investigate signature of disorder, imperfections and lattice defects one the properties of semiconducting 2D materials by a combination of scanning probe methods, optical and Raman spectroscopy.

[1] J. Klein et al. arXiv:1905.01242 (2019). [2] J. Klein et al. Nature Commun. 10, 10, 2755 (2019).

DS 29.7 Wed 15:00 P1A

Electron and exciton phonon interaction in gate tunable TMDC layers — •David O. Tiede[1], Hendrik Lambers[1], Margaux Lassaunière[1], Katharina Nisi[2], and Ursula Wurstbauer[1] — [1]Institute of Physics, University of Münster, Germany — [2]Walter Schottky Institute and Physics Department, Technical University of Munich, Garching, Germany

Semiconducting transition metal dichalcogenides are a class of 2D materials of great interest because of their unique properties such as valley selective optical excitation or phonon-mediated multi-valley superconductivity. Phonons are a significant mechanism for valley depolarization at elevated temperatures. We observe a significant coupling between the long-range oscillating electric field induced by the longitudinal optical (LO) phonon. This Fröhlich exciton LO-phonon interaction [1] is suppressed by doping and correlates with a distinct increase of the degree of valley polarization of up to 60 % even at elevated temperatures of 220 K [1]. Higher-doping is expected to turn the system to superconducting phase at low temperatures [2]. We study the electrical and optical response of gate tunable TMDC flakes by combined spectroscopic imaging ellipsometer, charge transport and Raman measurements.

[1] B. Miller et al. Nature Commun. 10, 807 (2019). [2] E. Piatti et al. Nano Lett. 18, 8, 4821-4830 (2018).

DS 29.8 Wed 15:00 P1A

Scanning-probe-induced assembling of gold striations on mono- and bi-layered MoS2 on SiO2 — Felix Trillitzsch[1], Arkadiusz Janas[2], Alper Özogul[1], Christof Neumann[1], Antony George[1], Benedykt R. Jany[2], Franciszek Krok[2], Andrey Turchanin[1], and •Enrico Gnecco[1] — [1]Friedrich Schiller University Jena, Jena, Germany — [2]Jagiellonian University, Krakow, Poland

Single crystal Au clusters have been collectively manipulated on mono- and bi-layered MoS2 islands grown on SiO2 using AFM. On the monolayer the clusters tend to move in a direction corresponding to the zigzag alignment of the Mo and S atoms, and to assemble into long stripes parallel to the scan direction. A detailed observation based on SEM shows that within each stripe the clusters remain separated by gaps of few nm in width possibly caused by electrostatic repulsion and/or the substrate roughness. The stripes also proved to be thermally stable, preserving their superstructures up to 823 K. On the bilayer gold clusters are less prone to move and assemble. Our results suggest that the formation of nanostructures from collective manipulation of metal clusters can be guided by a properly chosen scan path in a rather straightforward way.

DS 29.9 Wed 15:00 P1A

Dry-transfer of graphene and h-BN heterostructures onto hydrogen-terminated diamond — •Vasilis Dergianlis, Martin Geller, Dennis Oing, Nicolas Wöhrl, and Axel Lorke — Faculty of Physics and CENIDE, University of Duisburg-Essen, Lotharstr. 1, 47057, Duisburg, Germany

Graphene is a 2D carbon allotrope that exhibits exceptional mechanical strength and electron mobility. Due to its high electron conductivity, graphene is considered one of the best conductors and can be also used as gate electrode in transistor-type devices. A second very important carbon allotrope is diamond, which is a wide-bandgap semiconductor in its bulk form. Chemical vapor deposition (CVD) grown, hydrogen-terminated diamond exhibits surface conductivity by a two-dimensional hole-gas (2DHG).

In our work, we are combining the two aforementioned carbon allotropes. We implement a dry transfer method to position graphene onto diamond in a transistor-like structure, where h-BN serves as the gate-dielectric and graphene as a top gate.The sample consists of bulk CVD grown diamond, where the H-termination of the surface induces a 2DHG as a conductive surface layer [1]. Graphene and h-BN flakes are exfoliated and transferred from SiO_2 substrates onto the functionalized diamond surface. We show device characterization such as IV-characteristics and gate-dependent photoluminescence.

[1] Oing, D., et al. Diamond and Related Materials (2019): **107450**.

DS 29.10 Wed 15:00 P1A

Optical characterization and transport measurements on 2D Films with the squeezable nanojunction technique — •Alexander Fuchs, Matthias A. Popp, and Heiko B. Weber — Lehrstuhl für Angewandte Physik, Staudtstraße 7, 91058 Erlangen, Germany

We use the recently developed Squeezable Nanojunction techique [1] for simultaneous optical characterization and transport measurements on vertically contacted 2D-Materials. With our technique we can adjust the distance between two chip surfaces on the atomic scale. Due to the optically transparent nature of our silicon carbide substrate material the technique allows for investigations of the interplay between optical properties and electrical transport phenomena of distance controlled tunneling contacts between Graphene-Graphene, Graphene-MoS_2-Graphene, $MoS_2 - MoS_2$ ... structures. On this poster we present concepts and capabilities of our setup along with first results.

[1] M. A. Popp and H. B. Weber, Applied Physics Letters 115, 083108 (2019)