

DS 32: Poster: Optical Analysis of Thin Films

Time: Wednesday 15:00–18:00

Location: P1A

DS 32.1 Wed 15:00 P1A

Revealing The Chemical Structures Of Silicon Nanoribbons On Ag(110) Via DFT And Raman Spectroscopy —

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Silicon nanoribbons grown on Ag(110) exhibit a pentagonal Si structure along the missing row arrangement of the Ag surface [1]. Depending on the deposition temperature, nanoribbons can form a single- or a double-strand structure, which differs by the distance between the neighbouring chains. Even though double-strand nanoribbons have no bonds between the strands, the properties of the two single ribbons are influenced by their close proximity. In order to elucidate this interaction, we performed a combined study of single- and double-strand Si nanoribbons by Raman spectroscopy and density functional theory (DFT). The results show that nanoribbons exhibit a vibrational fingerprint distinct from 3D bulk Si or 2D silicene [2]. The vibrational signature is not only related to the pentagonal building block of nanoribbons, but also to their electronic properties, which are altered, when two Si nanoribbons are located in close proximity. This leads to a prominent Raman band around 380 cm^{-1} , a marker for the formation of double strand ribbons. The possible mechanisms and the origin of this band are discussed.

DS 32.2 Wed 15:00 P1A

Ultrafast pump-probe microscopy on MoSe₂ — •KONRAD BIRKMEIER^{1,2}, LUCAS LANGE¹, EDOARDO AMAROTTI¹, and ACHIM HARTSCHUH¹ — ¹Department of Chemistry and CeNS, LMU Munich, Germany — ²Toptica Photonics AG, Graefelfing, Germany

We investigate single and few layer MoSe₂ by ultrafast pump-probe spectroscopy and microscopy giving insight to the decay dynamics in the 2D material. The excitation of different excitonic states by the pump pulse causes changes in the transient reflectivity and can be probed and spectrally resolved by broadband whitelight pulses ranging from the visible to the near infrared. By the subsequent use of ultra short, wavelength tunable probe pulses the decay dynamics of the excited states can be investigated further with a high signal to noise ratio. In combination with the high spatial resolution of confocal microscopy the carrier dynamics at boundaries, wrinkles and other inhomogeneities will be discussed.

DS 32.3 Wed 15:00 P1A

Transient Scattering Microscopy and Non-Linear Raman response of Single-Layer Graphene — •LUCAS LANGE, VEIT GIEGOLD, RICHARD CIESIELSKI, and ACHIM HARTSCHUH — Department of Chemistry and CeNS, LMU Munich, Germany

We investigate the ultrafast response of graphene using transient scattering and non-linear Raman microscopy. In general, high electronic temperatures reached for pulsed excitation cause a partial Pauli-blocking of optical transitions. This leads to reduced transient absorption and hence enhanced reflection. Importantly, the transient reflectivity signal detected at different time delay and energy detuning between pump and probe pulse features pronounced spatial inhomogeneities in as prepared single-layer graphene. We discuss the decay dynamics of this transient response based on complementary Raman spectra. In addition, the hot electronic temperatures reached upon pulsed excitation are found to cause a partial Pauli-blocking of interfering quantum pathways contributing to resonant Raman scattering in graphene. As a consequence, the signal of the two dominant Raman bands G and 2D together with their ratio strongly depend on the laser intensity and result in a super-linear and sub-linear increase of the G band and 2D band intensity, respectively.

DS 32.4 Wed 15:00 P1A

Evaluation of thicknesses of polymer films on steel surfaces with spectroscopic ellipsometry — •FRIEDRICH BÜRGER, MARIA SONNENBERG, LIENHARD WEGEWITZ, and WOLFGANG MAUS-FRIEDRICH — Clausthaler Zentrum für Materialtechnik, Technische Universität Clausthal, Leibnizstraße 9, 38678 Clausthal-Zellerfeld, Germany

In the production of polymeric foils, on the used steel surfaces a polymer residue builds up, that needs to be cleaned off after a certain film thickness. For this process it is important to have an idea of the films thickness remaining on these surfaces in situ. Here we evaluate if spectroscopic ellipsometry could be adapted for this purpose. Various thin polycarbonate (PC) films were therefore prepared by spin-coating. To change the film thickness in a different manner the samples were here treated with a dielectric barrier discharge (DBD) plasma. Afterwards measurements with an ellipsometer and a confocal laser scanning microscope (CLSM) were performed. This was repeated several times with different PC film thicknesses and plasma treatment times. Additionally, X-ray photoelectron spectroscopy was performed on different samples to detect possible change in composition of the films and the steel surfaces due to plasma treatment. As the thickness of the film measured by the CLSM decreased with increasing plasma treatment time, the measurements with the ellipsometer reflected this change. This indicates that spectroscopic ellipsometry could be adapted to evaluate the thickness of PC films in situ on steel surfaces when other methods are unavailable.

DS 32.5 Wed 15:00 P1A

Effect of lattice strain on the surface structure of epitaxial manganite thin films — •LEONARD SCHÜLER, JONAS WAWRA, SEBASTIAN MERTEN, and VASILY MOSHNYAGA — I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Our recent study of the surface-enhanced Raman spectroscopy (SERS) revealed that La_{0.7}Sr_{0.3}MnO₃ (LSMO) thin films grown in a stress-free state on MgO(200) substrates possess an electron-enriched surface, that manifests itself by the appearance of strong Jahn-Teller stretching and antistretching modes in SERS spectra [1]. Here we were focusing on the effect of epitaxy strain on the surface structure of LSMO films, grown on LaAlO₃, SrTiO₃ and sapphire substrates by a metalorganic aerosol deposition (MAD) technique. Raman intensity of the substrate background has been reduced by optimizing the confocal setup of the spectrometer. The surface structure was then determined by comparing the conventional Raman spectra of films with their respective SERS spectra, obtained by coating the films with Au nanoparticles using the same MAD. Furthermore, the influence of the MAD surface modification on the SERS spectra has been investigated. Financial support of the DFG via SFB1073 is acknowledged.

[1] S. Merten et al. Phys. Rev. Mater. 3, 060401(R) (2019)

DS 32.6 Wed 15:00 P1A

IN-SITU INVESTIGATION OF ELECTROCHROMIC RADIATION PROCESSES IN TUNGSTEN TRIOXIDE THIN FILMS BY OPTICAL SPECTROSCOPY — •ALEXANDER STRACK¹, SIMON BURKHARDT^{1,2} und PETER J. KLAR^{1,2} — ¹Institute of Experimental Physics I, Heinrich-Buff-Ring 16, 35392 Giessen — ²Center for Materials Research(LaMa), Heinrich-Buff-Ring 16, 35392 Giessen

Smart-Windows with thin films of tungsten trioxide in the fenestration of buildings help to regulate heat transfer through windows and thus to reduce energy consumption for climatization. This approach is cost efficient and may contribute significantly to CO₂ reduction in the atmosphere. For the best performance of the smart window it is essential to understand what happens in the tungsten film and how to optimize the coloration process. Different spectroscopic techniques are employed to investigate the electrochromic coloring process in thin tungsten films. Raman spectroscopy reveals the different crystalline phases of WO₃ which occur during coloration. Simultaneous measuring the absorption and the current allows one to correlate the degree of coloration with the incorporated charge and with the crystalline phase of the material.

DS 32.7 Wed 15:00 P1A

Real-time pump-probe microscopy of single-shot laser thin film ablation — •TILL WACHWEGER — Universität Bayreuth

The interaction of single ultrashort laser pulses with materials allows for tailored phase changes and precise microprocessing. Despite existing ultrafast instrumentations, insights into fast irreversible phenomena in inhomogeneous materials and at individual positions are severely limited due to the lack of real-time acquisition. We present an inter-

ferometric real-time pump-probe microscopy setup which is used to study the lift-off of a metallic thin film layer. A sub-200fs laser pulse induces the ablation, and the lift-off progress is monitored via high repetitive interferometry based on the time-stretch Dispersive Fourier Transformation.

DS 32.8 Wed 15:00 P1A

Hyperspectral and Time-Resolved IR Laser Polarimetry —
 •CHRISTOPH KRATZ, ANDREAS FURCHNER, and KARSTEN HINRICHS
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 Germany

Beyond classical FT-IR and synchrotron IR spectroscopy, the analysis of composition, structure and heterogeneity of complex surfaces and thin films is significantly advanced by a new generation of IR polarimeters [1]. We developed a novel laser-based IR technique enabling time and spatially resolved 5D analytics by combining a tunable QC laser with a single-shot ellipsometer [2,3]. Specifications are 0.5 cm^{-1} spectral resolution, $<125\text{ }\mu\text{m}$ spatial resolution, $20\text{ }\mu\text{s}$ temporal resolution for single wavelength and 100 ms for spectral investigations [2,3]. Large area mapping ($50 \times 50\text{ mm}^2$) and time-resolved studies under ambient conditions [2], as well as coupling with humid or liquid flow cells for in-situ IR spectroscopy (e.g. IR nL microfluidics [4]) are possible. Presented examples are chemical and structural heterogeneity investigations of organic thin films, and the solid-liquid phase transition of a myristic acid film. Funding: EFRE 1.8/13, in cooperation with Sentech Instruments GmbH.

[1] K. Hinrichs et al, JVST B 37, 060801 (2019).

[2] A. Furchner et al., Optics Letters 44.19: 4893-4896 (2019).

[3] A. Furchner et al., Optics Letters 44.17: 4387-4390 (2019).

[4] C. Kratz et al., ACS Sensors, 3:299-303 (2018).

DS 32.9 Wed 15:00 P1A

Controlling the phase-change of $\text{Ge}_2\text{Sb}_2\text{Te}_5$ via ion beam doping —
 •ROBIN SCHOCK, MARTIN HAUFERMANN, KONSTANTIN RUFFERT,
 and CARSTEN RONNING — Institut of Solid State Physics,
 Friedrich Schiller University Jena, Max-Wien-Platz 1, 07743 Jena,
 Germany

The phase-change material $\text{Ge}_2\text{Sb}_2\text{Te}_5$ (GST) builds the basis for reconfigurable optical devices like rewritable data storage or switchable metasurfaces, because of its drastic differences in the electrical and optical properties accompanying the phase-change. In such devices switching between crystalline and amorphous states can be triggered by either electrical, thermal or optical external stimuli that exceeds a specific energy threshold. Although there is already a wide field of applications, a major flaw is the inability to tune the phase-change threshold for various applications. Doping of GST can be utilized to change the crystallization kinetics and enables the manipulation of the energy threshold. As doping during the growth process of GST films is limited, we used ion beam implantation for non-equilibrium doping, which enables us additional control of the lateral doping distribution. Thus, we implanted various ion species and doping concentrations into GST thin films and directly observed the phase-change via differential reflection measurements during heating of our samples. We show that ion beam doping is a powerful tool to tailor the phase-change temperature of GST over a broad temperature range.