DS 13: Layer Deposition II: Deposition Methods

Time: Monday 16:45–18:00 Location: CHE 89

DS 13.1 Mon 16:45 CHE 89

Real-Time Investigations during Sputter Deposition on Polymer Thin Films — •Matthias Schwartzkopf[1], Marc Gensch[1,2], Thomas Strunskus[3], Franz Faupel[3], Peter Müller-Buschbaum[2], and Stephan V. Roth[1,4] — [1]DESY, Notkestr. 85, D-22607 Hamburg — [2]TUM, James-Franck-Str. 1, D-85748 Garching — [3]CAU zu Kiel, Kaiserstr.2, D-24143 Kiel — [4]KTH, Teknikringen 56, SE-100 44 Stockholm

The reproducible low-cost fabrication of functional polymer-metal-nanocomposites remains a major issue in applied nanotechnology. In order to obtain full control over the nanostructural evolution at the metal-polymer interface, we employed time-resolved surface sensitive X-ray scattering during sputter deposition of gold on thin polystyrene films and silicon substrates [1,2]. We correlate the evolution of the metallic layer morphology with changes in the key scattering features. This enabled us to identify the impact of atomic deposition rate on the growth regimes with their specific thresholds [3]. Our study opens up the opportunity to improve nanofabrication of tailored metal-polymer nanostructures for organic electronics like photovoltaic applications and plasmonic-based technologies. [1] Schwartzkopf et al., ACS Appl. Mater. Interfaces 7, 13547 (2015); [2] Schwartzkopf et al., Nanoscale 5, 5053 (2013); [3] Schwartzkopf et al., ACS Appl. Mater. Interfaces 9, 5629 (2017).

DS 13.2 Mon 17:00 CHE 89

Real time video analysis of droplets in spray pyrolysis deposition process — •Jonas Köhling and Veit Wagner — Jacobs University Bremen, Campus Ring 1, 28759 Bremen, Germany

Spray pyrolysis is a cost-effective and scalable process used for deposition of thin functional films in areas of electronic, optics or even medicine. The properties of the thin films are influenced by the behavior of droplets with respect to the surface temperature of the substrate used for the deposition. Usually, smoother films were observed for temperatures higher than Leidenfrost temperature [1], which depends mainly on the solvent and the substrate.

In this work, we have developed a system to monitor the interaction of droplets smaller than 80 μm on a hot surface for a timescale below 1 ms. Such small droplets are produced by an ultrasonic atomizer and sprayed onto the substrate with controlled temperature. A high-speed camera with up to 10.000 frames per second is used to monitor the behavior of the droplets. Using a computer algorithm, the droplets are analyzed automatically and properties such as droplet size distribution and their lifetime have been determined. Analysis of the droplet lifetime allows for the systematic determination of Leidenfrost temperature and optimization of spray pyrolysis process for the thin film deposition.

[1] M. Ortel and V. Wagner, J. Cryst. Growth, 2013, 363, 185-189

DS 13.3 Mon 17:15 CHE 89

Atomic layer deposition of optical coatings on PMMA — •Pallabi Paul[1], Kristin Pfeiffer[2], and Adriana Szeghalmi[1,2] — [1]Institute of Applied Physics, Abbe Centre of Photonics, Friedrich Schiller University Jena, Germany — [2]Fraunhofer Institute for Applied Optics and Precision Engineering, Jena, Germany

Atomic layer deposition (ALD), based on self-saturating surface reactions, is a promising chemical coating technology due to its conformal film growth on complex shaped substrates. Thermoplastics like poly(methyl methacrylate) (PMMA) is an important alternative to glass optics and has widely been used in producing various optical components. However, precision coatings on plastics are rather challenging due to the tendency of crack formation and typically low adhesion of the dielectric coatings to the polymer surface. Thus, materials and processes need to be tuned to the particularities of specific polymer. In this work, optimization of ALD processes to develop uniform, homogeneous and dense optical thin films of Al2O3, TiO2 and SiO2 on PMMA has been carried out and a five-layer antireflection coating is demonstrated. While uncoated PMMA substrates have a reflectance of nearly 8% in the visible spectral range, the reflectance of double-sided antireflection coating does not exceed 1.2% in the spectral range of 420 nm to 670 nm with a total average reflectance of only 0.7%. Microscopic analysis of cross-hatch areas on PMMA indicates superior adhesion and excellent environmental stability of ALD coatings. Furthermore, 3D conformal growth of ALD films is exploited on PMMA dome ensuring identical spectra on the entire dome surface.

DS 13.4 Mon 17:30 CHE 89

One-step Synthesis of Carbon-supported Electrocatalysts — •Sebastian Tigges[1], Nicolas Wöhrl[1], Ivan Radev[2], Ulrich Hagemann[1,3], Markus Heidelmann[1,3], Thai Binh Nguyen[1,3], Stanislav Gorelkov[2], Stefan Schulz[1], and Axel Lorke[1] — [1]University of Duisburg-Essen and CENIDE, 47057 Duisburg, Germany — [2]ZBT GmbH, 47057, Duisburg, Germany — [3]University of Duisburg-Essen and ICAN, 47057 Duisburg, Germany

Cost-efficiency, durability and reliability are the main challenges in the commercialization of fuel cells, thus research is focusing on development of new material systems for use in electrocatalysis. Especially long-term stability needs to be improved, since degradation mechanisms lead to a reduced lifetime of conventional catalyst materials. Here, we present a novel, one-step approach to synthesize a metal/carbon-hybrid material by plasma-enhanced chemical vapour deposition, demonstrated for the model electrocatalyst Pt/C. Platinum loading, oxidation state, and particle size distribution of the catalyst can be fully controlled. Highly monodisperse size distributions and small mean particle sizes of the Pt nanoparticles are achieved. Due to the one-step nature of the process, the Pt nanoparticles are embedded into the support (carbon nanowalls), which improves long-term stability, while maintaining good electrochemical surface area. By using different precursors, the versatile synthesis process can be easily adapted to deposit other metal/carbon-hybrids for a variety of potential applications. Control of the functionalization and doping of the catalyst is discussed briefly.

DS 13.5 Mon 17:45 CHE 89

Epitaxial growth of Cr_2AlC MAX phase thin films by pulsed laser deposition — •Marc Stevens, Alexander Jemiola, Michael Farle, and Ulf Wiedwald — Faculty of Physics and Center for Nanointegration Duisburg-Essen, University of Duisburg-Essen, Germany

MAX phases ($M_{n+1}AX_n$) are ternary or quaternary compounds of layered hexagonal structures, where M is an early transition metal, A is an A group element and X is either C or N [1]. Within the last years, much attention is put on magnetic MAX phases with Cr and/or Mn as two possible M elements. The magnetic properties of such $(M1_xM2_{1-x})_2AX$ phases are driven by competing ferromagnetic and antiferromagnetic correlations leading to complicated phase diagrams [2,3]. One parent compound of such MAX phases is Cr_2AlC. In this work, we show the first successful synthesis of epitaxial Cr_2AlC films on MgO (111) substrates by pulsed laser deposition (PLD) at film thicknesses of 10-50 nm. The epitaxial relation is Cr_2AlC (0001) || MgO (111) in the growth direction and Cr_2AlC $[11\bar{2}0]$ || MgO $[10\bar{1}]$ in the film plane. We compare the growth of Cr_2AlC on MgO(111) and Al_2O_3(0001) and discuss the impact on the magnetic properties. Funding by the Deutsche Forschungsgemeinschaft (DFG) within the CRC/TRR 270 is gratefully acknowledged.

[1] M. W. Barsoum, Prog. Solid State Chem. 28, 201 (2000). [2] A. S. Ingason, M. Dahlqvist, and J. Rosen, J. Phys.: Condens. Matter 28, 43 (2016). [3] Iu. Novoselova et al., Sci. Rep. 8, 2637 (2018).