DS 16: Thin Film Application

Time: Thursday 9:30–12:30 Location: REC/C213

DS 16.1 Thu 9:30 REC/C213

An on-chip heating platform for localized thin-film repair, non-equilibrium microstructures, and phase control — •Nensi Toncich, Nerea Abando Beldarrain, Jacopo Simone Crippa, Henning Galinski, and Ralph Spolenak — Laboratory for Nanometallurgy, Department of Materials, ETH Zürich, Switzerland

Localized on-chip heat generation and rapid thermal quenching is critical for systematic probing of phase transitions of nanofabricated systems, tailoring non-equilibrium microstructures and localized thin-film repair. Here we introduce a reactive multilayer [1] based on-chip heating platform that enables temperatures above 1000 °C, millisecond-scale heating and self-quenching rates on the order of 10^5 °C s^{-1} while preventing chemical interdiffusion. Using a diffusion-resistant, thermally conductive barrier, this platform enables three distinct, reproducible outcomes across different material systems: (i) localized melting and reflow of Au to repair electrical discontinuities, (ii) controlled microstructural evolution of Au, transforming equiaxed grains into elongated, high-aspect-ratio structures that are difficult to achieve with conventional processing, and (iii) a monoclinic-to-tetragonal phase transformation in the ZrO_2, demonstrating precise, site-specific phase engineering.

By combining ultrafast, high-temperature thermal pulses with diffusion-stable barriers, this platform offers a unique strategy for precise, on-demand modification of thin films, with broad applications in electronics, functional coatings, and nanofabrication.

[1] Toncich N. et al., J. Appl. Phys. 137(17), 2025

DS 16.2 Thu 9:45 REC/C213

Enhanced resistive switching in hybrid perovskite-MoS2 memristors — •Georgios Chatzigiannakis[1,2], Anastasia Soultati[1], Spiros Gardelis[2], and Maria Vasilopoulou[1] — [1]INN, NCSR Demokritos, 15341 Athens, Greece — [2]Physics Department, National and Kapodistrian University of Athens, Panepistimiopolis Zografos, 15784 Athens, Greece

Memristors are emerging two-terminal devices with tunable resistance states and strong potential for next-generation non-volatile memory and neuromorphic computing. Their reversible switching between high- and low-resistance states (HRS/LRS), combined with non-volatile information retention, makes them attractive for energy-efficient data storage. Metal halide perovskites have recently gained interest in thin-film memristive technologies due to their low fabrication cost, solution processability, and rich ionic dynamics, while 2D TMDs such as MoS2 provide excellent interfacial properties that modulate charge transport and defect chemistry.

We demonstrate a hybrid perovskite memristor incorporating MoS2 nanosheets, exhibiting significantly enhanced electrical performance compared to pristine devices. The MoS*-integrated device achieves endurance up to 200 switching cycles, stable retention beyond 12 000 s, and a large memory window (HRS:LRS ~100). In contrast, the pristine device shows only ~25 cycles and a window below 50. These results highlight the crucial role of TMD:perovskite interfaces in stabilizing ion-migration pathways and improving resistive-switching reliability in hybrid thin-film memristors.

DS 16.3 Thu 10:00 REC/C213

Resistive Sensor for in situ electrical monitoring during atomic layer deposition — •Lucas Rave, Colin Schormann, Stefanie Haugg, Kristian Deneke, Jun Peng, Robert Blick, and Robert Zierold — Center for Hybrid Nanostructures, University of Hamburg, Germany

Atomic layer deposition (ALD) provides exceptional coating conformality with sub-nanometer resolution, driving the new semiconductor technology node processes. Conventional in situ diagnostics, such as spectroscopic ellipsometry and quartz crystal microbalances, focus on mass and optical morphology information during deposition. However, rich electrical information remains limited. To address this, we developed an electrical in situ monitoring detector capable of resolving resistance changes for individual precursor and purge pulses. This detector contains custom-patterned titanium electrodes on Si/SiO_2 substrates, whose resistance evolution directly reflects cycle-resolved ALD surface reactions. Using this approach, we probed the deposition process for oxides, including ZnO, Al-doped ZnO (AZO), and TiO_2, capturing characteristic signatures of nucleation delays, self-limiting ligand exchange, and dopant-induced conductivity changes. Our method reveals how different precursor chemistries manifest in distinct electrical transients and provides a quantitative link between surface reaction kinetics and film evolution. The resistance-based in situ sensing offers a practical, compact, and integrable diagnostic tool for understanding and optimizing ALD processes, enabling improved control over thin-film quality in micro- and nanofabrication.

DS 16.4 Thu 10:15 REC/C213

Molecular insights into the mechanical and dynamical properties of mechanically interlocked polymer thin films — •Yang Wang[1], Andrea Giuntoli[1], and Xuzhou Yan[2] — [1]Zernike Institute for Advanced Materials, University of Groningen, 9747 AG Groningen, Netherlands; — [2]State Key Laboratory of Synergistic Chem-Bio Synthesis, Frontiers Science Center for Transformative Molecules, School of Chemistry and Chemical Engineering, Shanghai Jiao Tong University, Shanghai 200240, P. R. China;

Mechanically interlocked networks (MINs) comprise molecular components connected by mechanical bonds, introducing topological constraints that alter deformation pathways. Coarse-grained molecular dynamics simulations are used to investigate substrate-supported and free-standing MIN thin films based on [c2]daisy chain architectures, with systematic variation of extension distance, cross-linking degree, interfacial cohesive strength, and strain rate. Strongly attractive substrates induce pronounced dynamic confinement, whereas weak adhesion leads to enhanced, free-surface-like mobility. Rings exhibit slower dynamics than axle chains, whose mobility is governed by proximity to binding sites. Pull-out and biaxial deformation simulations reveal a three-stage ring-sliding mechanism that suppresses excessive bond scission, maintains network connectivity at large strains, and delays macroscopic failure, thereby enhancing toughness and energy dissipation. These results provide molecular-level insight into MIN thin film mechanics and inform the design of adaptive, energy-dissipating polymer materials.

15 min. break

DS 16.5 Thu 10:45 REC/C213

A Pathway Towards All-Optical Light-Propagation Switching — •Jakob Lindenthal, Frithjof Pietsch, Markas Sudzius, Johannes Benduhn, and Karl Leo — TU Dresden, Institut für Angewandte Physik, Nöthnitzer Str. 61, 01187 Dresden

Dynamic switching of the light propagation is a key enabler for integrated nanophotonic circuits. Optical gratings are a widely used, versatile component for coupling light into and out of waveguides. However, their diffraction efficiency is generally set and limited well below unity by static design and process parameters such as etch depths or geometric profile quality. We experimentally demonstrate the use of a dielectric-mirror cavity for enhancing the diffraction efficiency of grating couplers beyond these intrinsic limits. Using a second counter-propagating input beam achieves near-perfect dynamic control of the coupling amplitude. The experiments are backed by analytical and numerical modeling of the cavity-enhanced diffraction efficiency and the interaction of light waves in optical-gratings multiport devices. These findings extend the concept of coherent perfect absorption (CPA) from thin absorbing layers to diffractive structures, providing an all-optical propagation switching mechanism for efficient signal input and control in compact photonic circuits and nano-optic systems.

DS 16.6 Thu 11:00 REC/C213

Investigation of Temperature-Dependent Loss Mechanisms in Tantalum and Niobium Thin-Film Coplanar-Waveguide Resonators — •Philip Schneider[1], Moritz Singer[1], Harsh Gupta[1], Benedikt Schoof[1], and Marc Tornow[1,2] — [1]TU Munich, Garching, Germany — [2]Fraunhofer EMFT, Munich, Germany

Superconducting qubits can enable scalable quantum computing. Niobium (Nb) is widely used as the base superconductor, but tantalum (Ta) can improve performance by hosting fewer two-level system (TLS) losses, especially in its native oxide. We sputter-deposited Ta and Nb thin films on silicon and studied three stacks: pure Nb, Nb with a

thin Ta cap, and Ta on a thin Nb seed layer, realizing distinct interface scenarios. The thin films were characterized by resistivity, critical temperature, RRR and X-ray diffraction. Coplanar waveguide resonators were fabricated from the $\sim$ 200 nm films to determine their internal quality factor (Q_i) in the few GHz regime. Temperature- and power-dependent measurements (100-1700 mK, -80 to -160 dBm) were fitted with a combined TLS-quasiparticle loss model to analyze loss-channels. To probe the effect of native oxide at the metal-air interfaces, the resonators were re-measured post four weeks of air exposure. In the single-photon regime at 100 mK, the average Q_i changes from 1.38×10^6 (BOE) to 1.19×10^6 (native oxide) for Nb, from 1.58×10^6 to 1.11×10^6 for Ta-capped Nb, and from 1.07×10^6 to 1.20×10^6 for Ta on an Nb seed layer. Thus, while all stacks provide Q_i in the 10^6 range, Nb-based devices degrade post oxidation, whereas the Ta dominated film remains robust and even slightly improves.

DS 16.7 Thu 11:15 REC/C213

Gallium phosphide on insulator for integrated quantum photonics — •Tobias Bucher[1], Otto Arnold[1,2,3], Katsuya Tanaka[1,2,3,4], Muyi Yang[1,2,3,4], Carsten Ronning[1], and Isabelle Staude[1,2,3,4] — [1]Institute of Solid-State Physics, Friedrich Schiller University Jena, 07743 Jena, Germany — [2]Abbe Center of Photonics, Friedrich Schiller University Jena, 07745 Jena, Germany — [3]Institute of Applied Physics, Friedrich Schiller University Jena, 07745 Jena, Germany — [4]Max Planck School of Photonics, Germany

Gallium phosphide (GaP) emerges as a promising material for quantum nanophotonics due to its high refractive index with low absorption in the visible, combined with a strong second-order nonlinear response and the absence of linear birefringence. Growing high-quality, single-crystalline GaP thin films on low-index substrates, however, faces challenges due to lattice and thermal mismatch, and process complexity in common epitaxial methods. Here, we demonstrate ion slicing of GaP thin films and anodic bonding onto low-index glass substrates. We fabricate GaP thin films from (100) and (110) bulk crystals with thicknesses of 760 $\pm$ 40nm. Structural and optical characterisation is used to optimise the implantation and bonding conditions with the goal of achieving high-optical quality and low absorption suitable for nanophotonic applications.

DS 16.8 Thu 11:30 REC/C213

Enhancement of photoluminescence of Er3+ ions by Mie-resonant silicon nitride metasurfaces — •Fengkai Wei[1,2], Carsten Ronning[1], Duk-Yong Choi[2], Xinru Ji[3], and Tobias Kippenberg[3] — [1]Institut für Festkörperphysik, Friedrich Schiller University Jena, Germany — [2]Research School of Physics, Australian National University, Australia — [3]Institute of Physics, Swiss Fed- eral Institute of Technology Lausanne (EPFL), CH-1015 Lausanne, Switzerland

Mie-resonant high-index dielectric nanoparticles and metasurfaces have been suggested as a viable platform for enhancing both electric and magnetic dipole transitions of fluorescent emitters. While previous work has demonstrated the enhancement of magnetic dipolar transitions from Eu3+ ions using silicon nanocylinders, this approach was limited by silicon's strong absorption at the Eu3+ emission wavelength in visible range. Erbium features a characteristic infrared emission wavelength of 1550nm, which is widely used in telecommunication. It makes Er a good candidate of emitters in metasurface for infrared applications. This study explores the enhancement of Er3+ ions using dielectric metasurfaces composed of Mie-resonant silicon nitride metasurface. Er3+ ions were introduced into the metasurface via ion implantation. Strong room-temperature photoluminescence (PL) was only observed after annealing, which activates the ions.Maximum PL enhancement occurred at a nanocylinder radius of ˜410 nm, aligning with simulations. This study demonstrated a significant ˜40-fold PL enhancement on metasurface over a planar reference.

15 min. break

DS 16.9 Thu 12:00 REC/C213

Use of hybrid electrochromic devices for dynamic solar control in buildings — •Eleftheria Merkoulidi and George Syrrokostas — Solar Energy Laboratory, Department of Physics, University of Patras, Rion, Greece

Nowadays, the three main sectors that consume a lot of primary energy are: transport, industry, and buildings. Especially in the EU during 2023, buildings were responsible for 40% of total energy consumption, for approximately 50% of all-natural gas use, and a large portion of this energy (80%) is dedicated specifically to heating, cooling, and hot water supply for occupants. Therefore, improving the energy efficiency of buildings is critical. One effective way to improve energy efficiency is by controlling the significant energy losses (up to 60%) that occur through windows. These losses are caused by heat transfer mechanisms (conduction, convection, and radiation), as well as air leakage. A promising technological solution involves the use of adaptive chromogenic windows, such as electrochromic smart windows (ECWs). They can improve the energy efficiency of a building by modulating the sunlight and solar heat entering a building in real time, by changing their appearance (from transparent to opaque), under an applied electric field. In the present study, a way to improve their optical performance is investigated, by using a cobalt based redox electrolyte as a novel alternative to other redox couples used so far, with promising results.

DS 16.10 Thu 12:15 REC/C213

Influence of Crystal Orientation on the Oxygen Evolution Reaction in La_2NiMnO_6 Films — •Felix Tegtmeyer[1], Pia Henning[2], Shagun Thakur[2], Tobias Meyer[2], Ulrich Ross[3], Vasily Moshnyaga[4], and Jasnamol Palakkal[2] — [1]Department of Ultrafast Dynamics, Max Planck Institute for Multidisciplinary Sciences, Göttingen, Germany — [2]Institute of Materials Physics, University of Göttingen, Germany — [3]4th Physical Institute, University of Göttingen, Germany — [4]1st Institute of Physics, University of Göttingen, Germany

Double perovskites such as La_2NiMnO_6 (LNMO) promise applications for catalysis in energy storage and conversion. However, investigations of the oxygen evolution reaction (OER) in LNMO remain limited to nanoparticles and powders while the effects of crystal orientation remain elusive. In this work, we study monocrystalline LNMO thin film catalysts grown by metalorganic aerosol deposition at ambient air. By controlling the facet which is in contact with the electrolyte, the influence of crystal orientation is identified. We found that the activity of LNMO films with (100) crystal orientation is enhanced by one order of magnitude compared to (111) oriented films. We attribute this to the availability of both Ni and Mn active sites for the (100) surface. Moreover, an overall enhancement of the activity is identified for higher thicknesses. In long-term chronoamperometry measurements, the LNMO film retains a high activity and excellent bulk stability while the degradation is limited to a surface-near region.