UNIVERSITÄT SALZBURG

DEPARTMENT OF
CHEMISTRY AND PHYSICS OF MATERIALS

ANNOUNCEMENT

Vortragsankündigung

Mittwoch, 2. Dezember 2026, 11.15 Uhr im SR I

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TUM School of Natural Sciences

"Solar Energy Conversion at the Nanoscale"

The efficiency and stability of solar energy conversion systems are governed by processes occurring at surfaces and interfaces, where local structure, electronic properties, and chemical reactions meet. Nanoscale variations in composition, defects, and surface morphology can strongly influence charge transport, catalytic activity, and degradation. Yet these properties are often characterized using macroscopic measurements that average over local differences. Understanding how nanoscale structure and dynamics translate into device performance therefore requires methods that can probe materials and interfaces with high spatial resolution, ideally under operating conditions.

In this talk, I will present two complementary approaches to bridging this gap, with a particular focus on nanoscale characterization and scanning probe microscopy. First, I will discuss how structural, chemical, and optoelectronic heterogeneity in polycrystalline semiconductor thin films influences their photoelectrochemical properties. Grain boundaries, crystal orientations, and local compositional variations create a complex landscape of electronic and chemical properties that cannot be captured by bulk measurements alone. By correlating spatially resolved characterization with photoelectrochemical performance, we identify local factors governing efficiency and stability and use these insights to guide materials optimization.

Second, I will demonstrate how in situ atomic force microscopy (AFM) provides direct insight into dynamic processes at working solid–liquid interfaces. Using photocathodes for solar hydrogen evolution as a model system, we investigate how the nanoscale morphology of Pt catalysts influences performance and durability. We compare continuous Pt films with Pt nano-island onto TiO_2-protected photocathodes. Despite showing similar initial photoelectrochemical performance, the two catalyst architectures exhibit different long-term stability: the continuous Pt films delaminate, whereas the nanostructured Pt remains stable. In situ imaging reveals distinct gas bubble formation and evolution at the electrode surface, providing a direct link between catalyst morphology, interfacial dynamics, and degradation. Together, these studies illustrate how nanoscale characterization, particularly under operating conditions, can uncover mechanisms hidden in conventional measurements and enable the rational design of more efficient and durable solar energy conversion systems.