DS 10: Gaede Prize Talks

Time: Tuesday 9:30–11:30 Location: H17

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Prize Talk DS 10.1 Tue 9:40 H17

Atomic-Scale Optical Spectroscopy at Surfaces — •Takashi Kumagai — Fritz Haber Institute, Berlin, German — Institute for Molecular Science, Okazaki, Aichi, Japan — Laureate of the Gaede-Prize 2020

Light-matter interactions can be largely enhanced in the presence of optical near fields. Atomic-scale light-matter interactions in plasmonic "picocavities" has emerged as a new frontier of fundamental light science and technology [1]. However, the investigation of such light-matter interactions still involves significant challenges in both experiment and theory. A combination of plasmon-enhanced spectroscopy with low-temperature STM can provide a unique way to investigate intriguing physics resulting from the strong interaction between cavity-mode plasmon and matter even at atomic scales [2]. I will discuss our recent development toward atomic-scale optical spectroscopy in plasmonic STM junctions [3].

References: [1] Nat. Mater. 18, 668 (2019). [2] Nat. Rev. Phys. 3, 411 (2021). [3] Phys. Rev. Lett. 128, 206803 (2022); Nano Lett. 22, 2170 (2022); ACS Photonics 8, 2610 (2021); Nano Lett. 21, 4057 (2021); Nano Lett. 20, 5879 (2020); Nano Lett. 19, 5725 (2019); Nano Lett. 19, 3597 (2019).

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Prize Talk DS 10.2 Tue 10:20 H17

Slow highly charged ions as a tool for monolayer sensitive nano-engineering — •Richard Wilhelm — TU Wien, Institute of Applied Physics, Vienna, Austria — Laureate of the Gaede-Prize 2021

Heavy ions in high charge states can be prepared with kinetic energies in the keV energy range. These slow ions interact with surface electrons upon impact of a material which leads to their neutralisation and consequently to the deposition of several ten keV of potential energy. Over the past 20 years it has been a puzzle how fast and consequently how surface sensitive this energy deposition is. With the use of free-standing two-dimensional materials we can now limit the interaction time of the ions with a solid to the femtosecond regime. We find that most of the neutralisation of the ions takes place in a single atomic monolayer of material. In this contribution I will discuss recent advancements in the study of ion neutralisation dynamics inside of solids as well as the efficiency of potential energy driven sputtering of atoms. The latter depends on the type of material and can be confined to a single monolayer only, despite the high amount of deposited energy.

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Prize Talk DS 10.3 Tue 11:00 H17

Quantum Science with Single Atoms and Molecules on Surfaces — •Philip Willke — Karlsruhe Institute of Technology, Physikalisches Institut, Karlsruhe, Germany — Laureate of the Gaede-Prize 2022

The quantum nature of a physical system often emerges from its fundamental building blocks and demands a profound understanding to harvest its advantages for quantum devices. In this talk, I will introduce a new architecture for coherent control of spins on surfaces, by combining electron spin resonance (ESR) and scanning tunneling microscopy (STM) [1]. This technique allows to address single atoms and molecules on surfaces with unprecedented energy resolution. Thus, it can be used to sense the magnetic coupling between spin centers on the nanoscale [2]. In addition, when scanning the STM tip across the surface it permits to perform magnetic resonance imaging on the atomic scale [3]. The high energy resolution also grants access to the hyperfine interaction between the electron and nuclear spin of different atomic species [4]. Recently, we could extend this technique also to spin resonance on individual molecules [5]. Lastly, by employing pulsed ESR schemes, a coherent manipulation of the surface spin becomes possible, for instance in Rabi and Hahn echo schemes [6]. This opens up a path towards quantum information processing and quantum sensing using atomic building blocks, including atoms and molecules. [1] S. Baumann et al., Science 350 (2015) [2] T. Choi et al. Nat. Nano 12 (2017) [3] P. Willke et al., Nat. Phys. 15 (2019) [4] P. Willke et al., Science 362 (2018) [5] X. Zhang et al., Nat. Chem. 14 (2022) [6] K. Yang et al., Science 366 (2019)