Prize Talk PRV II Wed 13:15 HSZ 01

Towards chemical and optical band structure engineering in molecular-based heterostructures — •Benjamin Stadtmueller — Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — Institute of Physics, JGU Mainz, 55128 Mainz, Germany — Laureate of the Gaede-Prize 2023

Optical excitations with femtosecond light pulses offer the intriguing opportunity to control material properties on ever-shorter timescales down to the duration of the optical excitation itself. One of the most promising ways to reduce the timescale of the ultrafast material response is to exploit optical-induced spin and charge transfer processes that can directly act on the material's band structure and its population. In this presentation, I will introduce molecular-based heterostructures as a highly intriguing platform to chemically and optically tailor charge and spin carrier functionalities on the nanoscale. Using time-, spin- and momentum-resolved photoemission with fs-XUV radiation, I will first demonstrate that optical excitation of charge transfer states in molecular materials can instantaneously alter the local energy level alignment within the molecular film on ultrafast timescales [1,2]. This approach can be transferred to heterostructures between molecular and 2D semiconductors where it allows us to transiently uncover the otherwise hidden spin polarization of the prototypical layered semiconductor WSe2. These findings will open new avenues for optical controlling and functionalizing spin phenomena in molecular-based heterostructures on ultrafast timescales. [1] Nat. Commun. 10, 1470 (2019), [2] J. Electron. Spectros. Relat. Phenomena 252, 147110 (2021).