Unraveling Hot Carrier Transfer Processes in Plasmonic Energy Devices

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In the last decade, plasmonic nanoantennas have revolutionized light manipulation and control at the nanoscale. Interestingly, generation of hot carriers in metals upon light absorption have opened new pathways for controlling photo(electro)chemical processes and engineering photocatalysts. Yet, fundamental questions remain about the microscopic details of these complex light-matter interactions.

We have recently developed a well-controlled platform for micro-scale plasmonic photoelectrochemistry studies that leverages the unique properties of monocrystalline microflakes [1] as well as precise nanofabrication methods. Interestingly, the microflakes exhibit well-defined crystal facets and can bridge the properties of bulk metals with those of nanoscale plasmonic antennas, accessing ultra-thin film dimensions (sub 15-nm) that are challenging for polycrystalline films. Furthermore, our nanofabrication approach combines top-down and bottom-up methods to achieve high quality nanoantennas. By performing careful absorption measurements, we explore the photoelectrochemical performance of these hot carrier micro-scale photoelectrodes for inner- and outer-sphere reactions, concurrently comparing them to cm-scale devices [2]. This allows us to unravel the interplay of hot carrier generation and transport at metal-liquid and metal-semiconductor interfaces and identify bottlenecks for charge transfer.

References

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[2] Ma J., Oh K., Tagliabue G. - Understanding Wavelength-Dependent Synergies between Morphology and Photonic Design in TiO2-Based Solar Powered Redox Cells – Journal of Physical Chemistry C 2022

Biography

Dr. Giulia Tagliabue is a Tenure-track Assistant Professor in the Department of Mechanical Engineering at EPFL. She joined the Engineering faculty in January 2019 and she is the head of the Laboratory of Nanoscience for Energy Technologies (LNET). She obtained her PhD in Mechanical Engineering from ETH Zurich in 2015. From 2015 to 2018 she was a Swiss National Science Foundation Fellow and she carried on her postdoctoral research jointly at Caltech and the Joint Center for Artificial Photosynthesis (JCAP). Dr. Tagliabue's research focuses on the study of fundamental mechanisms and nanophotonic-design strategies for light-energy conversion devices, with a special interest for light-energy storage systems. Dr. Tagliabue is the recipient of the First Prize of the Rising Stars of Light Award 2020 and the 2021 Early Career Award in Nanophotonics. In 2020 she was awarded an Eccellenza Grant from SNSF and in 2022 she received an SNSF Starting Grant. She is member of the Material Research Society (MRS), the American Chemical Society (ACS) and the Optical Society of America (Optica). Dr. Tagliabue is currently Managing Editor of the journal *Nanophotonics* (DeGruyter).