3D Photovoltaics Group

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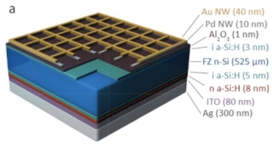
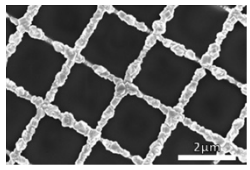
Research Theme: The goal of the 3DPV group is to push the frontiers of solar energy conversion by developing new low-cost nanofabrication methods, new concepts in light trapping and light-driven chemistry.

Projects 1 & 2: Electrochemical fabrication of nanopatterned materials for PV devices

Supervisors: Yorick Bleiji, Daphne Antony, and Esther Alarcon Llado



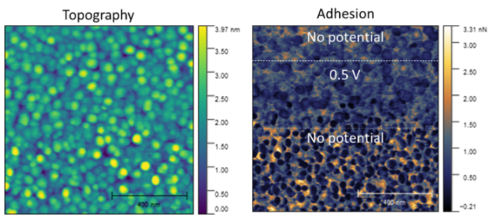


New materials and methods are needed to enhance the performance of solar cell devices. In these projects, you will investigate a new template-assisted electro-chemical method for patterning carrier selective contacts and perovskite materials onto conventional device architectures. Project 1 focuses on simulating and fabricating MoO_x and NiO_x on Si as selective carrier contacts to make full solar cell devices. Project 2 aims at the functional patterning of lead halide perovskites with enhanced optical functionality. These are a great opportunity to gain valuable experience in the fields of materials science, renewable energy, and optoelectronics, and to work with state-of-the-art equipment and techniques.

Projects 3 & 4: Nanoscale mapping of the electrocatalytic activity

Supervisors: Daphne Antony, Antony Litovoilis and Esther Alarcon Llado

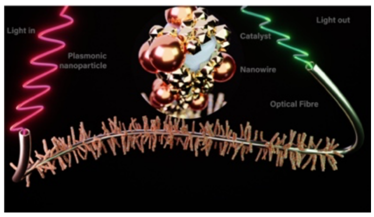
Delve into the exciting world of electrocatalysis with these cutting-edge research projects designed for motivated graduate students. Our goals are to unravel the connection between the electrochemical active sites and their local nano-mechanical properties. Project 3 entails synthesizing single-crystal and polycrystalline gold electrodes, followed by in-depth in-situ analysis using SECM-Atomic Force Microscopy under electrochemical conditions. Project 4 focuses on studying the electrochemical activity in individual plasmonic metal nanoparticles under resonant illumination. Engage in these stimulating opportunities to explore correlations between topography, adhesion forces, deformation, and activity in the quest for sustainable technology solutions.



Project 5: Optical designing for Novel Optically Driven Catalysis Technology

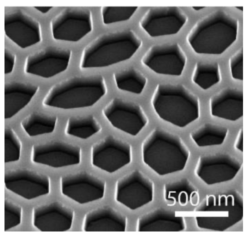
Supervisors: Jaime Rivera and Esther Alarcon Llado

This project focuses on the design of novel light-driven chemical reactors. One of the key challenges in light-driven catalysis is how to distribute the light in reactors, where catalyst nanoparticles on ceramic supports are pressed together into the form of opaque pellets. In this project, you will work on a new photonic concept that overcomes this challenge. You will use computational tools for the photonic designing and fabricate the most promising structures. You will learn cleanroom fabrication methods and optical microscopy for the fabrication and characterisation of the new photonic reactors.



Project 6: Hyperuniform Light Trapping Via Large-Area Self-Assembly

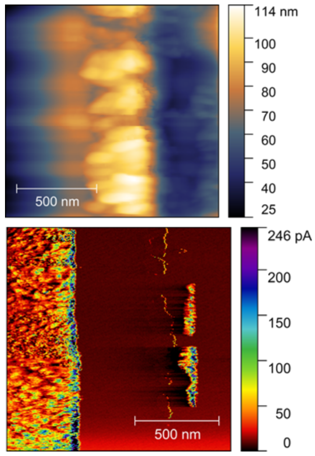
Supervisors: Alex Lambertz and Esther Alarcon Llado



Hyperuniform nanopatterns are exceptional light trappers in thin films as they remedy the shortcomings of periodic and random texturing approaches. You will establish hyperuniform self-organizing on very large scales and combine it with nanofabrication techniques as well as acquire expertise in optical and electrical characterization of solar cells. You will explore different deposition routes and try to gain control on the nanometer scale by adjusting macroscopic process parameters.

Project 7: **Probe Force Microscopy Measurements of solar cells**

Supervisor: Melanie Micali



Kelvin Probe and conductive Force Microscopies (KPFM and c-AFM) are nanoscopic techniques that simultaneously map topography, work function and conductance in metals and semiconductors. This project focuses on the KPFM and c-AFM study of a new class of solar cell materials: Zn_3P_2 and hybrid perovskite. In-plane and device cross-sectional measurements will be performed under different conditions, both in equilibrium and out of equilibrium conditions (under bias and/or under illumination) to pinpoint the origin of photocurrent and of electrical losses in the device.