3D Photovoltaics Group

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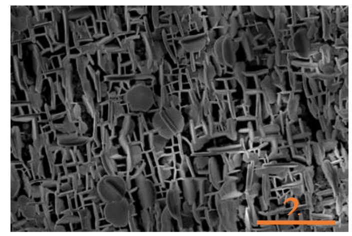
Research Theme: The goal of the group 3D Photovoltaics is to push the frontiers of nano-PV by aiming towards the achievement of low-cost semiconductor nanostructures as building blocks. We focus on the fundamental understanding of the potential benefits and/or limitations of semiconductor nanostructures when used for solar energy conversion. These include exploring non-traditional conversion principles enabled by the nano geometry or the development of cost-effective nanofabrication methods.

Project 1: New synthesis route for 2D perovskites

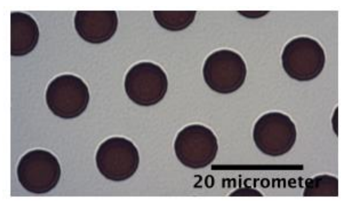
Supervisors: Daphne Antony and Esther Alarcon Llado



2D Hybrid Perovskites are self-assembled quantum well structures that are excellent light absorbers and light emitters. Due to their stability and high defect tolerance, they find applications in solar cells and LEDs. However, the quantum confinement in these perovskites can affect the charge extraction in solar cells, if improperly oriented along the contacts. The crystallization process and orientation control of these perovskites are still poorly understood. We use a new combination of electrochemistry and ion exchange process that may allow control over the orientation of 2D perovskite sheets. We will further investigate the fundamental questions regarding the conversion process steps, the role of water as a catalyst and understand the crystallization kinetics of perovskites with other halide ions.

Project 2: Will it lase? Fabrication and study of metal halide perovskite micro lasers

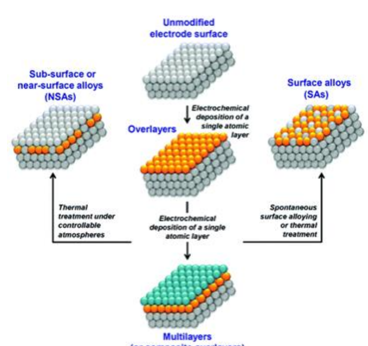
Supervisors: Juliane Borchert and Esther Alarcon Llado



Metal halide perovskites are an emerging class of semiconductors that are being studied extensively for use in solar cells. They not also absorb light very well, they also emit it and are therefore being developed for use in light emitting devices (LEDs). In this project we want to utilize this material class for another type of light emission: lasing. The goal is to model, design, and fabricate perovskite micro disk lasers. These are interesting for future integration into optical circuits. For this project we will use FDTD simulations to decide on the optimal design for these micro lasers which we will then fabricate using lithography and thin-film vapour deposition. To characterise the lasers we will use, atomic force microscopy, electron microscopy, and a range of spectroscopy methods. The research will be carried out in collaboration with researchers at the University of Cambridge.

Project 3: Electrochemical growth of III-V semiconductors

Supervisors: Yorick Bleiji and Esther Alarcon Llado



Common growth techniques of III-V semiconductors require expensive equipment, which prevents that they can be used for large scale photovoltaic's. In this project, you are going to grow InAs using a low energy, low-cost technique: electrochemistry. Specifically, we are going to explore the electrochemical analogy of atomic layer epitaxy, ECALE. The idea here is to electro-deposit alternatively a layer of In and As, which then react to InAs. Such a cycle could repeat many times to grow a thick InAs layer. You will learn the basics of electrochemistry, and you will design and develop your own ECALE setup using an electrochemical flow cell. After the successful deposition of InAs, we will study the crystal growth of InAs using broad range of equipment.