Nanoscale Solar Cells group (AMOLF)

Prof. Erik Garnett
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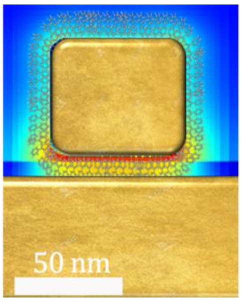
Research theme The *Nanoscale Solar Cells* synthesizes advanced metal and semiconducting nanostructures, characterizes their material properties and integrates them into novel device structures.

Project 1: Plasmonic chemistry in nanogap cavities

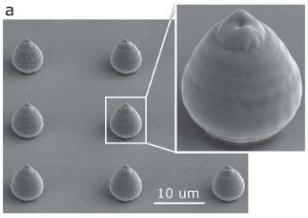
Supervisors: Eitan Oksenberg & Erik Garnett



Gold nanocubes separated by only a few nanometers from gold mirrors can act as strong antennas that funnel and concentrate light into very small volumes. In this project, you will fabricate these plasmonic structures and use them as tiny chemical reactors to drive and study a new type of chemistry. This plasmon-driven approach has the potential to generate more selective and efficient chemistry while working under mild conditions. You will study and monitor the chemistry inside these nano-reactors using single-particle extinction and Raman spectroscopies.

Project 2: Directional emission of in situ grown emitters using arrays of nanolenses

Supervisors: Julia van der Burgt, Susan Rigter and Erik Garnett



A good performing solar cell should not only absorb sunlight efficiently, is should also be an efficient light emitter. Causing this light to be emitted into a narrow angle beam can lead to more efficient solar cells. In our research group we have recently shown how nanolenses can do this for quantum dots and nanowires. We have also seen that light driven formation of emitters underneath the lens can give highly directional emission, using mixed halide perovskite thin films. The next step in this research is to achieve such an effect on larger areas rather than individual nanolenses, to get closer to application in actual solar cells. In this project we will investigate array effects and metasurfaces to create directivity from larger areas, with a combination of optical simulations and experimental work. Dependent on your interest, you can focus on understanding the mechanism behind the in situ grown perovskite emitters and optimize this, or focus on optimizing the arrays of nanolenses.

Developing back contact perovskite solar cells with an efficiency over 20%

Supervisors: Hongyu Sun and Erik Garnett

One of the big projects in our group is the development of a back contact perovskite solar cell. There are three different aspects within this project, each of which could form a full masters project.

1. Passivating the perovskite absorber layer to fabricate highly efficient solar cells. You will work on making solar cells from scratch, and work on ways to passivate the perovskite absorber layer.
2. Manufacturing metal grids. Our group has previously proposed a new perovskite solar cell configuration, making use of back contacts. You will work on many different nanofabrication techniques, such as PDMS stamping, E-beam and UV lithography, and characterize the results using a wide variety of tools, such as AFM, SEM, and EDX.
3. Discover perovskite thin film grown in a strained structure, using EBSD. At AMOLF, we own a unique electron back-scatter diffraction (EBSD) detector, which is the only one in the world that can be used on fragile materials such as perovskites. EBSD is an electron-microscope based crystallographic technique. Using this technique, you will learn more and try to optimize the growth mechanism of the perovskite absorber layer on top of the grid of the back contact solar cell.