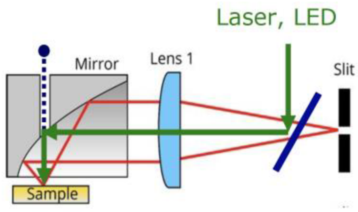
Photonic Materials group (AMOLF)

Prof. Albert Polman
polman@amolf.nl; www.erbium.nl

Research theme The *Photonic Materials* group studies the interactions between light, electrons, and matter at the nanoscale. We develop new materials and concepts for solar cells with improved efficiency, create optical metasurfaces that can perform mathematical operations (optical computing), and use time-resolved cathodoluminescence spectroscopy to study ultrafast optical phenomena at the nanoscale. All these topics are strongly linked and we have a strong culture of collaboration within our group.

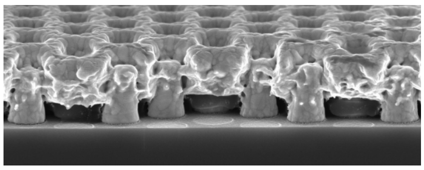
Project 1. Cathodoluminescence spectroscopy of laser-induced phase transformations for roll-to-roll perovskite solar cells
Supervisors: Albert Polman

In this project you investigate the formation of perovskite solar cells by using a novel annealing (heating) technique using intense laser or LED irradiation. You will use our time-resolved cathodoluminescence scanning electron microscope (SEM-CL) to study the optical and electrical properties of perovskite films. In CL we scan a nanoscale electron beam over the surface and simultaneously collect the luminescence spectrum. This provides insight in the perovskite bandgap, defect states and carrier lifetime at high spatial resolution. You will integrate a tunable laser source in the SEM-CL system and investigate if we can identify changes in structure and composition of the perovskite films under illumination in the SEM.



Project 2. Light trapping nanopatterned back contacts in perovskite/silicon tandem solar cells
Supervisors: Albert Polman

Perovskite/silicon tandem solar cells have the potential to reach sunlight-to-electricity conversion efficiencies above 35%. So far, this has not been demonstrated, one of the reasons being incomplete light coupling and trapping in the top and bottom solar cells. In this project you will design and fabricate a novel light trapping architectures for the back and intermediate contacts of a perovskite/silicon solar cells. You will use numerical simulations, cleanroom nanofabrication, soft nanoimprint lithography, and optical scattering measurements, and you will integrate your designs with a Si/perovskite solar cells to test the enhanced light trapping in the visible and near-infrared spectral range.



Project 3. Cathodoluminescence spectroscopy of photonic modes in dielectric nanostructures
Supervisors: Evelijn Akerboom and Albert Polman

Control and understanding over the interaction between light and nanostructures can improve light trapping in solar cells. In this project you will use high-energy electrons to excite resonant optical modes in dielectric nanostructures and collect and analyze the spectra and angular distribution of the emitted light in order to gain insight in how the structure interacts with light. The goal is to design the structure such that the excited resonances in the structure interfere destructively in the far field, creating understanding how light is best trapped in the solar cell. You will use numerical simulations, cleanroom nanofabrication, and cathodoluminescence spectroscopy to design and test such resonances in dielectric nanostructures.