## Photonic Materials group (AMOLF)

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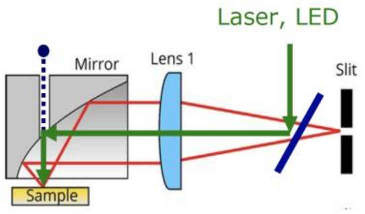
**Research theme** The *Photonic Materials* group studies the interactions between light, electrons, and matter at the nanoscale. We develop new materials and concepts for solar cells with improved efficiency, create optical metasurfaces that perform mathematical operations (optical computing), and use 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

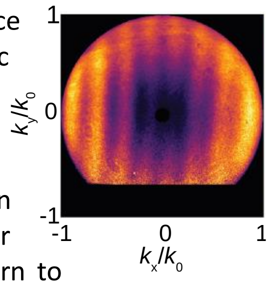
*Supervisors*: TBD & Albert Polman




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. Ultra-sensitive heterodyne cathodoluminescence spectroscopy

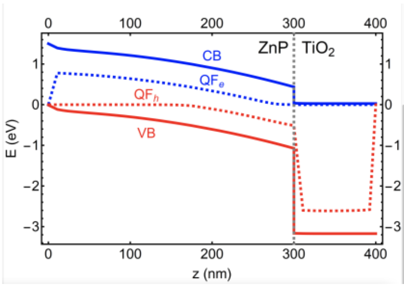
*Supervisors*: Evelijn Akerboom and Albert Polman




In this project you will use an optical interference technique to strongly enhance the sensitivity of cathodoluminescence spectroscopy of nanophotonic structures. You will use electron excitation in our scanning electron microscope to excite plasmonic resonances in noble metal nanoparticles and detect the plasmon radiation in the far field, while interfering it with a reference signal created by transition radiation that is simultaneously generated by the electron beam. By recording the interference signal in both the frequency and angular domain the measurement sensitivity will be strongly enhanced. You will learn to operate the SEM-CL microscope, perform electron beam lithography to fabricate plasmonic structures and use numerical modelling to analyze your data.

### 3. High-efficiency earth-abundant $Zn_3P_2$ solar cells

*Supervisors*: Stefan Tabernig and Albert Polman




Zinc-phosphide is an interesting photovoltaic material that is recently being explored for high-efficiency solar cells. It is composed of fully earth-abundant elements and can be made using vacuum crystal growth techniques. It has very strong optical absorption so that very thin films (1-2 µm) can make an efficient solar cell. Recently, in collaboration with EPFL (Lausanne) we have designed a $Zn_3P_2/TiO_2$ layer geometry that has promising carrier collection characteristics. in this project you will perform optical and electronic simulations to optimize the full solar cell design and perform optical and electronic characterization of the layers that are fabricated at EPFL.