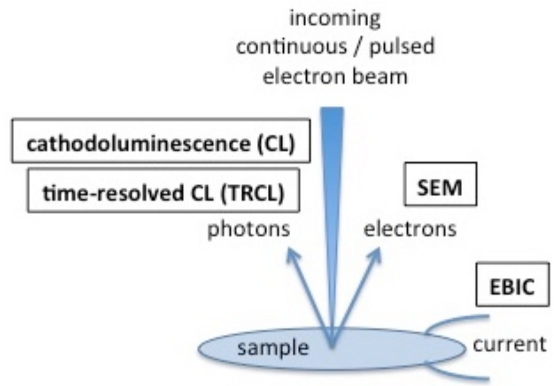
Time-resolved cathodoluminescence: multiscale characterization of photovoltaic materials

Centre de Nanosciences et de Nanotechnologies, Palaiseau

Contact: stephane.collin@c2n.upsaclay.fr

A unique cathodoluminescence (CL) tool has been installed at C2N in late 2015 with state-of-the-art capabilities (only three similar setups exist worldwide). Its basic principle is the following (see the figure): a material is excited with an electron beam in a scanning electron microscope (SEM), providing a spatial resolution of 10nm. Secondary electrons (SE), emitted photons (cathodoluminescence, CL) and even electron-beam-induced current (EBIC) are collected and recorded simultaneously in order to form 2D maps. For each spatial position, CL spectra provide information on the luminescence efficiency, band structure and defects. In our tool, laser-controlled bunches of electrons can also be used for excitation instead of a steady-state excitation beam, resulting in time-resolved CL measurements (TRCL) that provide valuable information on carrier dynamics and lifetime. Our CL/TRCL setup has state-of-the-art specifications and is extremely versatile: wide ranges of wavelengths (200nm-1600nm) and temperatures (10K-350K), time-resolved measurements (temporal resolution 10ps). In addition, its very high collection efficiency on a wide field of view is perfectly adapted to CL and TRCL mapping of a wide variety of photovoltaic (PV) materials.



This project is focused on polycrystalline semiconductor materials (CdTe, CIGS, perovskites) for PV in the framework of internal and collaborative projects. The goal of the internship is to perform multiscale CL/TRCL mapping in order to investigate the impact of (large-scale) inhomogeneities, of localized defects (at the nanoscale), of the size and shape of grains, and of the passivation of grain boundaries. The results will be analyzed and correlated to the macroscopic properties and efficiency of PV devices.

The candidate will be first trained on the CL/TRCL tool. Then, she/he will use this technique to perform and analyze multiscale CL/TRCL mapping of selected series of samples, with the goal to develop new methods to reveal the dynamics of carriers (lifetime, diffusion length, recombination velocities at interfaces...) and correlate these properties to the functional parameters of solar cells. In this context, she/he will work with several members of the *sunlit* team (C2N) and in close collaboration with the "*Institut photovoltaïque d'Ile-de-France*" (IPVF). A PhD position on CL/TRCL characterization of photovoltaic nanomaterials may be opened in 2019.