Summery

Organic solar cells made of conjugated polymers and fullerene acceptors are one of the most promising technologies for achieving low cost energy from solar power. A major limit of such material combination is the low photocurrent efficiency determined by a number of photophysical and transport phenomena. First most of the photons from the solar spectrum are not absorbed by the active materials, because of their optical gaps lying in visible part of the spectrum and because of the very thin active layers. Second recombination limits the maximum amount of photogenerated charge carriers possibly contributing to the usable current. This is ultimately controlled by the charge transport properties of the materials, which are considered to be very poor in pristine organic semiconductors.

In this proposal we aim to tackle and understand some of the most important loss mechanisms of polymeric solar cells by using p-B-n organic junctions. These junctions are prepared by a sequential deposition of high performance materials to achieve better photovoltaic efficiencies. The proposed structures are composed of three layers consisting of a p-doped conjugated polymer (p), a bulk heterojunction blend (B) and a top layer of fullerene with n-doping (n). The layers, being solution processed from different solvents, should have a certain degree of interpenetration ensuring smooth interfaces and a gradient of chemical potentials for improved directional charge separation and transport towards the respective electrodes. Doping is expected to reduce ohmic losses and reduce the series resistances, improving the fill-factor and thus the efficiency of solar cells. In addition, doped layers should allow for the use of thick bulk heterojunction layers capable of harvesting a high photon density.

The project aims to understand some of the fundamental questions in the physics of organic solar cells, concerning light absorption, charge transfer and recombination, transport in doped organic materials and morphology control. This research plan relies on the established expertise in the partner groups in the areas of photophysics, material processing and optoelectronic characterization of organic semiconductor blends.