

Abstract

Blends of polymers and inorganic nanoparticles (NP) offer a large number of applications in the field of organic electronics and gained increasing attention within the last decades. The optical and electrical processes within those blend layers are dominated by the structure of the involved materials in the range of few nanometers. In this dimension most of the established characterisation techniques (like electron microscopy) reach their limits.

This work presents nondestructive experimental methods and models for the characterisation of thin blend films composed of CdSe NP and several conjugated polymers, and their application in organic solar cells. The optical properties are obtained by spectroscopic ellipsometry and transmission measurements in addition to optical modeling. These properties comprise many information on the morphology of the pristine and blended polymer and NP films, like the preferential orientation of polymer chains or the diameter of the nanoparticles. In combination with the so-called *transfer matrix method* these results are used to determine the light yield of real and hypothetical devices.

With the presented methods the volume fraction of the polymer in such blend films is determined. With this information the optical processes within the films can be quantified. By comparing simulations with real device parameters the quality of the electric transport networks can be studied. The resulting volume fractions are between 0.16 and 0.26 for optimised solar cells, which is far below the value of 0.5 assumed in literature. Further, as a result of the optical models the composition is not constant over the film thickness of only several tenths of nanometers. This is confirmed by high resolution electron microscopy. A new optical model parameter for the shape of the blended domains is introduced and tested on correlations with solar cell parameters. Additional considerations allow for the quantitative characterisation of the organic layer capping the NP. This layer is required for synthesis and for processing.

These results demonstrate a new access for the understanding of the formation and transport processes of free charges within those blend films, and might also be transferred to other topics.