# Quantum dot solar cells and hybrid devices

Maria Antonietta Loi

University of Groningen, Zernike institute for Advanced Materials,
Nijenborgh 4, NL-9747 AG Groningen, The Netherlands

Colloidal semiconductor nanocrystals (NCs) are solution processable semiconductors that are potentially highly appropriate for optoelectronic device fabrication, owing to their narrow bandwidth, their remarkably broad absorption spectrum obtained because of quantum confinement, their high dielectric constant, and their high stability under ambient conditions.
In spite of the interest drawn by these systems the results up to now have been disappointing. Most of the problems reside in the dichotomy between quantum confinement, and necessity of electronic wave function overlap to allow electrical transport. This problem is mostly related to the insulating nature of the organic ligands used to passivate and solubilize the NCs.
I will report about the strategies my group have been using to overcome these problems making NCs useful for optoelectronic applications. These strategies involve the use of organic molecules for the fabrication of functional interfaces between the NCs and the external world.
The physical phenomenon underlying the working mechanism of these hybrid organic-inorganic systems is either electron transfer between the inorganic NCs and organic molecules [1] or tunnelling/hopping obtained by substituting the insulating ligands with functional linkers [2]. Following the second strategy by using benzene dithiols ligands to cross-link lead sulphide (PbS) NCs we obtained solar cells with power conversion efficiencies approaching 4% (Fig. 1) [2] and fill factors of 60% under AM1.5 illumination. In my presentation I will discuss the effect of different NCs` size on the performance and key parameters of the devices will be discussed together with peculiar physical features of the device functioning [3].

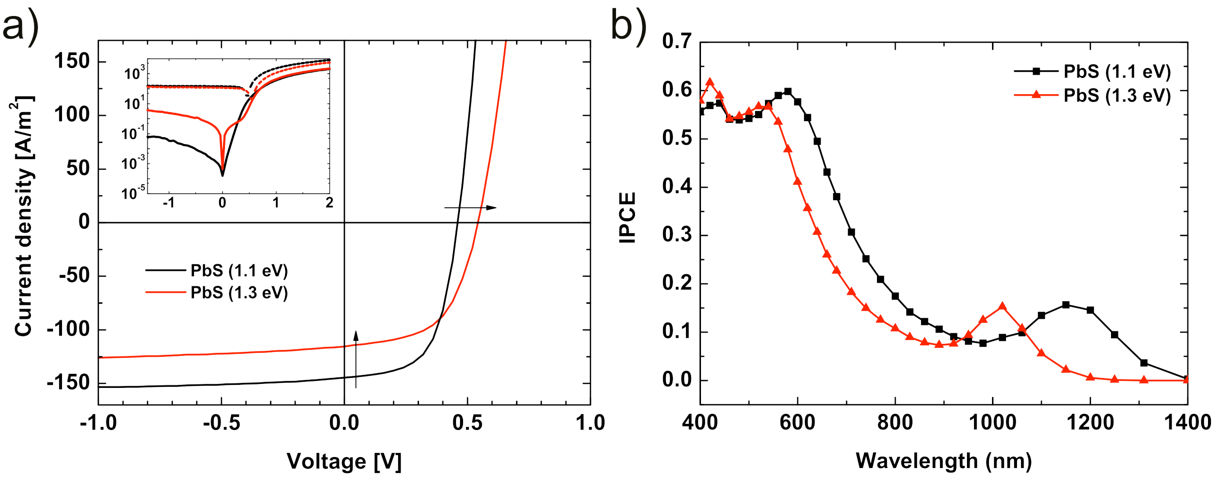


**Figure 1.** a) J-V characteristics of PbS solar cells composed of 2 different types of NCs having bandgaps of 1.3 and 1.1 eV. The inset shows the corresponding J-V curves on a logarithmic scale. b) IPCE spectra of PbS solar cells.

Finally I will show a simple method to realize efficient hybrid bulk heterojunction solar cells based on lead PbS and a low band gap polymer, poly(diketopyrrolopyrrole–terthiophene), by applying a post-deposition treatment for ligand exchange. A proper combination of the two materials, with matching absorption spectra (Fig. 2), as well as the optimization of the device, leads to the formation of an energetically favourable hetero-junction with broad spectral response and PCE of 3%[4].

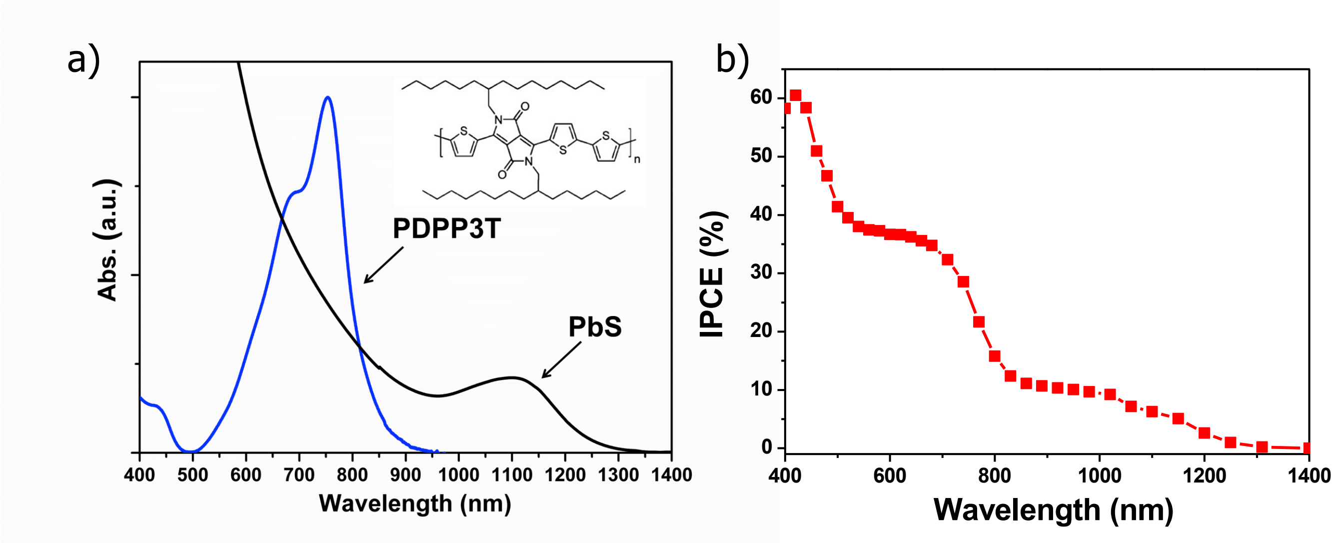


**Figure 2.** Absorption spectra of PDPP3T film (blue line), OA-capped PbS nanocrystals dispersed in toluene. The inset shows the molecular structure of the PDPP3T polymer. b) IPCE spectra of PbS-PDPP3T solar cell.

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