2 page abstract

Micro- and nano-patterned electrodes for organic solar cells and other interface dominated solar cells

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Organic solar cells are strongly dominated by the internal interface between an electron donating and an electron accepting blend of materials. Unlike to classical solar cells, the generation and separation of the electrical charges after photoexcitation occurs in dimensions which are in the range below 10 nm and at times scales in the femto second regime. This makes the primary charge separation very efficient and relative insensitive to impurities in the materials. The photo-excited state or exciton is transferred in a blend of materials from an organic semiconducting polymer like polythiophene to the surrounding matrix of an organic electron accepting material like e.g. fullerene C_{60}. This results in the dissociation of the exciton to an electron-hole pair. The electron is delocalised on the C_{60} in this case and the hole remains on the polymer.

Whereas the high internal surface is beneficial for the efficient generation of charge carriers a negative effect can be stated for the transport of the charges. The large number of surface states enhances direct and indirect recombination of the charge carriers and simultaneously reduces the charge carrier mobility. This limits the optimum thickness of the photoactive layer in organic solar cells to approximately 200 nm at the moment. We are investigating micro- and nanopatterend electrode concepts in order to overcome these limitation. The purpose of microstructured electrodes is mainly to increase the number of absorbed photons through enhancing of the optical pathlenght in the photoactive layer. Nanostructured electrodes on the other hand offer the possibility to reduce the electrical pathlenght of the charge carriers. Two distinct electrode geometries can be realised in this case, i.e. buried grid concepts and interdigital electrode concepts. The presented structures (figures 1 to 4) are on acrylic foils and have been replicated from masters which are produced at Fraunhofer ISE by holographic methods. Metallisation has been done by selective evaporation. The periodicity of the structures is 720 nm at the moment. For future experiments a period of 300 nm seems to be realistic. The structures are also open for discussion as potential electrodes for other interfacial dominated solar cells concepts.

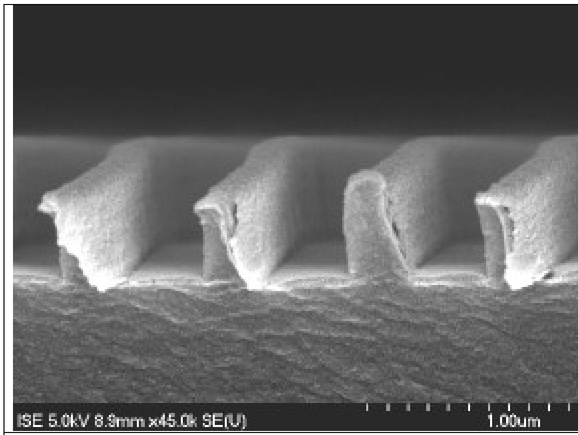

Figure 1: SEM image of electrode structure with vertical one sided metallisation. The structure can be used in a buried grid concept assuming the incident light coming from below through the transparent substrate foil.

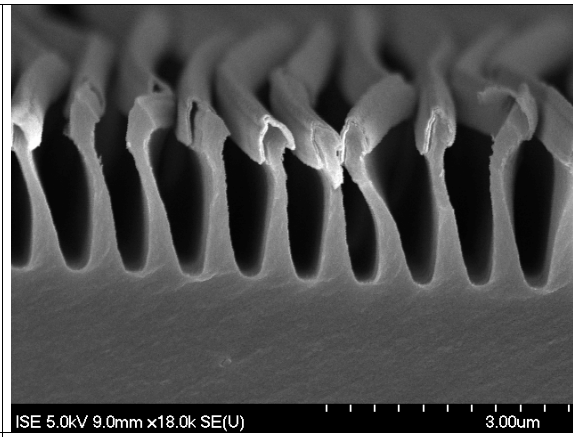

Figure 2: similar to figure 1, but much deeper structuring (depths approx. 2000 nm). The metallisation in this case is applied as caps on top of the structure. Electrical contact to the cavities would have to be made e.g. by applying a thin transparent layer of a conducting polymer like PEDOT.

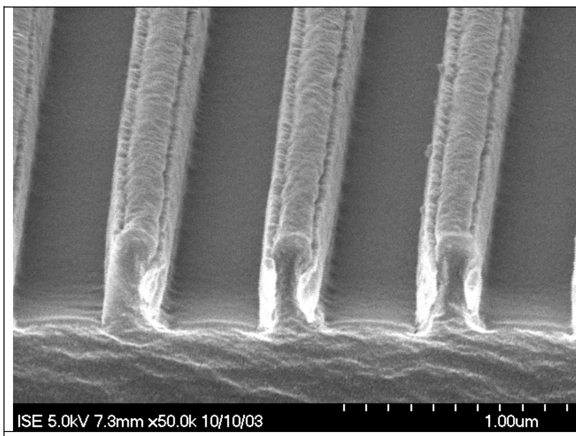

Figure 3: SEM image of electrode structure with two-sided vertical metallisation. Both sides of the metallisation are electrically isolated at the top of the structure resulting in a true 2-sides selective electrode setup. Distance between the electrodes approx. 400 nm.

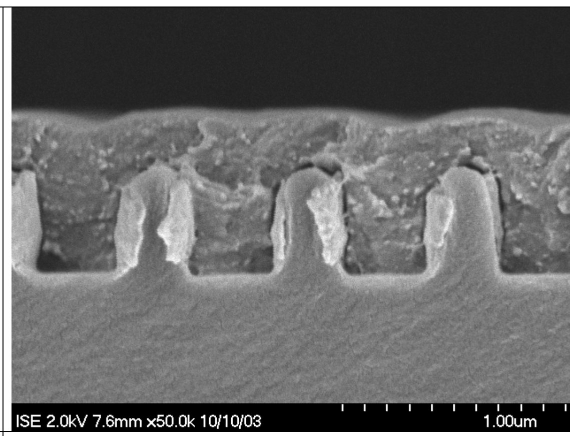

Figure 4: same as figure 3 but electrode structure coated with photoactive organic blend (fullerene / polythiophene). In this case no additional counter electrode is required in principle.