Diploma Thesis evaluation

Author of Diploma Thesis: BSc. Bright Amponsah

Diploma Thesis: **„Organic Photovoltaic Cells with HTL Layer Based on Conductive Polymers"** by Bright Amponsah.

The aim of this diploma thesis is organic photovoltaics.

Within theoretical part it deals with the description of materials used for organics photovoltaics and focuses especially on conductive polymers like PEDOT: PSS. Additionally, different structures used for organic photovoltaiccells are described which usually employ multi-layered inner structure.

Utilization of organic photovoltaics offers solution-based deposition methods such as spin coating or screen printing is described in Chapter 2.

The theoretical part of this work also describes characterization methods for organic photovoltaics such as ellipsometry and atomic force microscopy. Important photovoltaic parameters describing the performance of the organic solar cell such as open circuit voltage or power conversion efficiency are also explained.

The experimental part focuses on totally 9 samples of solar cell devices with multi-layer structures consisting of glass/ITO/ZnO/PTB7-Th: IEICO4F/Fluorinated PEDOT: PSS/PEDOT: PSS layers with different thicknesses of PTB7-Th: IEICO-4F and PEDOT: PSS deposited by spin-coating. Additionally, a single layer of PEDOT: PSS and ITO were available. Primary non-destructive optical methods such as UV-VIS spectroscopy and ellipsometry were used for their analysis. The thicknesses of the HTL showed a good match of values when ellipsometry analyses were performed with confirmation of these thicknesses from profilometry measurements.

Finally, measurements of the device performance in means of photovoltaic parameters under standard illumination by AM 1.5 G were conducted. The J-V characteristics of the OPV device in four different places were used to obtain V_{oc}, J_{sc}, FF, and PCE with a maximum V_{oc} = 0.54 V, J_{sc} = 6.9 mA/cm^2, FF = 38%, and PCE = 1.44%. Values of PCE about 6 % reported by [101] for typical organic photovoltaic cells are higher compared to our measurements. A bandgap of 3.38 eV determined from the UV-VIS spectroscopy measurement for the PEDOT: PSS may result in specific energy level alignments that

optimize charge transfer processes in the device. The bandgap of PEDOT: PSS also affects the energy level alignment at interfaces within the OPV device.

The surface roughness value of PEDOT: PSS obtained from the AFM measurement agreed with the values reported in the literature. In addition, the FTIR analysis performed on the multilayer was similar to the PEDOT: PSS.

Although maximum PCE is lower than values reported in recent literature. There is a hope for the utilization of organic photovoltaic cells with HTL layer based on conductive polymers measured within this work on the market. Generally, the positives of organic photovoltaics are that they are cheap and therefore more affordable in comparison with inorganic photovoltaics cells based on Silicon or perovskite materials. Moreover, solution-based deposition methods with lower deposition/annealing temperatures allow using flexible substrates.

When defending the diploma thesis, I ask that the author of the diploma thesis comment on the following:

- The J-V characteristics of the OPV device in this were used to obtain V_{oc}, J_{sc}, FF, and PCE. Could author compare this value with typical value for Si photo-diode measured by author in virtual laboratory within another class during his study?

By comparing the results of the work with its assignment, it can be stated that the goals of this work were clearly met. The thesis is very carefully written, in a traditional structure, with a negligible number of typos.

The author of the diploma thesis worked on a completely new topic, which is not easy and brought a number of difficulties associated with it, which the author managed to tackle. In solving it, the author demonstrated the ability of independent scientific work and the initiative in acquiring new knowledge.

I rate the diploma thesis and its processing as **„A“ excellent**.

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prof. Ing. Tomáš Wágner, DrSc