

Reviewer report of thesis of Zuzana Mrazkova.

The thesis submitted by Zuzana Mrazkova for defence on the 24.11.2017, entitled 'Modeling and characterization of materials and nanostructures for photovoltaic applications', is reviewed here. The thesis concerns the development of optical characterization methods, mainly in-situ and ex-situ spectroscopic ellipsometry for photovoltaic structures using more advanced light harvesting strategies than just rough interfaces and antireflection coatings. In particular, the thesis involves characterization and discussion of the light harvesting performance of pyramidal structures that form during etching of mono crystalline silicon, and characterization and discussion of plasma assisted VLS growth of Silicon nanowires. Both reflectometry (using integrating spheres) and imaging polarimetric set-ups have been additionally used. Some of the optical polarimetric systems provide the full Mueller matrix in single shot measurements. All optical models are supported by SEM direct imaging.

The thesis focuses on two systems: 1) pyramidal structures on single crystal n-type silicon, combined with manufacture of a-Si:H cells on these. 2) Silicon Nanowires produced with a combination of plasma assisted Liquid Vapor Solid method.

Context, settings and manuscript

The thesis is performed at the interface between materials synthesis and characterization and modelling. The thesis concerns two important light harvesting technologies: pyramidal micro-structuring of the surface of monocrystalline silicon, and Silicon Nanowires grown by a modified vapour liquid solid PECVD method. The thesis appears to have been performed in collaboration with several researchers (PhD/Post docs) involved in the synthesis and material manufacture. The thesis candidate has been supervised by experts in both material science and optical characterization, and performed in a co-tutelle between two institutions.

Strengths of thesis:

As a result of participation in a strong project team, the thesis involves the discussion of a large amount of samples (which takes a long time to manufacture and optimize), and structures, and the thesis as such appears overall as a very impressive document, which further appears as a good reference. The scientific method is sound and the results are mainly well founded. In addition, as the thesis is well written, well organized and contains systematically high quality figures, the thesis manuscript appears overall of high quality. The thesis is further a result of a fruitful international collaboration probably highly educative for the candidate and most useful for the two hosting institutions.

Weaknesses of thesis:

-The thesis does not discuss the model for the full scattering properties of the pyramidal structures. The author is co-author on a paper dealing with this issue, but this work is not included in the thesis?

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- The thesis does not discuss depolarization issues from neither pyramidal nor SiNW systems, neither record sufficient information in order to discuss these issues.
- The modelling of the Silicon nanowires uses a surprisingly simple isotropic effective medium model, completely neglecting the anisotropy of the pillars/wires? This simplification appears to me unphysical, and neglecting to discuss these issues is clearly the weakest part of the thesis. It can be argued that the results comes out promising, and hence as such the anisotropy can be neglected....? Some of the optical polarimetric systems provides the full Mueller matrix in single shot measurements, but the full Mueller matrix have been little explored in this work, therein particularly lacking a discussion of depolarization/anisotropy of both systems studied.
- The thesis does not discuss at all the economic viability of using high quality single crystalline wafers with poor quality a-Si:H multilayers.

General questions to candidate (such as discussing why the uniaxial anisotropy was neglected throughout the thesis) and other issues to be addressed to the candidate during the defence, are listed separately.

Statistical Analysis of the candidate and the thesis

The candidate lists 4 peer-reviewed journal publications, out of which the candidate is first author on 3/4. The candidate lists 5 conference proceedings, being first author on 4/5.

Web of science supplies 7 documents with 6 total citations by 6 documents (h-index: 2). The journal proceedings are not in high impact journals, except perhaps for the Journal of Nanoscience and Nanotechnology, a paper that is unfortunately not described in the thesis. However, the quantity of papers by the candidate largely outweighs the lack of high impact publications. The number of publications and presentations in addition to the quality of the written document, shows that the candidate is a good author and a good communicator.

Conclusions

The thesis manuscript is worth being defended. The quantity of the scientific output of the thesis appears above average and relates well to the expectations of a thesis in Scandinavia. The quality of the scientific output is good and beyond average in such a competitive field. The manuscript is well written and appears as a good reference document. Some critical issues here documented and listed separately are proposed to be discussed with the candidate during the defence.

Yours Sincerely,



Morten Kildemo
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