DS 8: Thin film photovoltaics: oxides and nanostructures

Time: Monday 16:30–18:00 Location: H 2032

DS 8.1 Mon 16:30 H 2032

Si-nanosponge embedded in SiO_2 as a new absorber material for photovoltaics — •Bartosz Liedke[1], Karl-Heinz Heinig[1], Bernd Schmidt[1], David Friedrich[1], Arndt Mücklich[1], Jeffrey Kelling[1], and Dirk Hauschild[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf , 01314 Dresden, Germany — [2]LIMO Lissotschenko Mikrooptik GmbH, 44319 Dortmund, Germany

Silicon based nanostructures became within the last years most promising material for the PV market. Quantum confinement effect of nanostructured silicon allows for band gap engineering just by size manipulation to absorb the light in more efficient way.

Here, we consider SiO_x layers fabricated by magnetron co-sputter deposition, which after thermal treatment decompose into a network of Si nanowires embedded in SiO_2. The thermally activated spinodal decomposition is performed by rapid thermal processing within a few seconds and by very rapid thermal processing within several ms using diode laser. The morphology and crystallinity of the Si-nanosponge was measured by energy filtered TEM and Raman, respectively. The details of decomposition are studied using the atomistic kinetic Monte-Carlo (KMC) simulations at different concentrations defined by the x parameter. The spatiotemporal temperature profiles $T(x,t)$ of the scanned laser has been calculated as a function of thickness and time by the heat transport equation. The obtained profiles are used in the KMC. The combined theoretical and experimental investigations support the band gap engineering of the Si-nanosponge absorber via a control of the quantum confinement.

DS 8.2 Mon 16:45 H 2032

Combination of Zinc Phthalocyanines and Zinc Oxide for Hybrid Solar Cells — •Michael Kozlik, Steffen Milz, Roman Forker, Alina Donat, Sören Paulke, Carsten Ronning, and Torsten Fritz — University of Jena, Institute of Solid State Physics, Max-Wien-Platz 1, 07743 Jena, Germany

Zinc phthalocyanine (ZnPc) is an organic molecule with high absorbance [1]. In combination with zinc oxide (ZnO) the interface forms a p-n-junction [2]. Therefore, the materials can be used in hybrid solar cells, i.e., photovoltaic devices made of organic and inorganic materials in order to utilize the advantages of the two material classes: high absorbance and good conductivity, respectively [3]. In our work, we investigate the planar sandwich setup and nanostructured devices, the latter consisting of ZnO nanowires covered with ZnPc. The interface between the two materials is analyzed by scanning electron microscopy (SEM), together with energy dispersive X-ray spectroscopy (EDX) and photo electron spectroscopy (PES) to characterize the electronic properties. The results of UV-Vis spectroscopy and external quantum efficiency (EQE) measurements highlight the generation of excitons in ZnPc and link these with the photo current in the visible range.

REFERENCES

[1] N. Papageorgiou et al., Prog. Surf. Sci. 77 (2004) 139.
[2] C. Ingrosso et al., Electrochim. Acta 51 (2006) 5120.
[3] S. Günes et al., Inorg. Chim. Acta 361 (2008) 581.

DS 8.3 Mon 17:00 H 2032

Sol-Gel Templated Zinc oxide Films for Solar Cell Application — •Kuhu Sarkar, Monika Rawolle, Eva M. Herzig, Weijia Wang, and Peter Müller-Buschbaum — TU München, Physik-Department, LS Funktionelle Materialien, James-Franck-Str. 1, 85748 Garching, Germany

Zinc oxide (ZnO) nanostructures are synthesized on silicon substrates forming different morphologies comprising of foam-like structures, worm-like aggregates, circular vesicles and spherical granules. The synthesis is using a sol-gel mechanism coupled with an amphiphilic diblock copolymer polystyrene-block-polyethyleneoxide, P(S-b-EO), acting as a template. The different morphologies are designed by adjusting the weight fractions of the good-poor solvent pair and the ZnO precursor, zinc acetate dihydrate (ZAD). To visualize the compositional boundaries of various morphologies, a ternary phase diagram is mapped. The surface morphologies of the ZnO nanostructure are studied with scanning electron microscopy (SEM). The inner structures of the samples are probed using grazing incidence small angle X-ray scattering, complementing the SEM investigations. X-ray diffraction measurements are performed to confirm the crystallization of the ZnO to the wurtzite polymorph phase upon calcination of the nanocomposite film in air.

DS 8.4 Mon 17:15 H 2032

DC magnetron sputtering of ZnO:Al from metallic and reduced ceramic targets: comparison of ion energy distributions — •Christian Wilde and Mykola Vinnichenko — Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Dresden, Germany

Magnetron sputtering is a common technique for deposition of transparent conductive oxides (TCO) such as Al-doped ZnO (AZO). The film growth using either metallic (reactively) or reduced ceramic targets often show different properties and morphology even in case of optimized processes. Therefore it is crucial to understand differences in magnetron plasma leading to such variations of properties.

The energy of ions emitted from the target in these processes is important, because it influences nucleation and the quality of the TCO. The negative ions with energies high enough to damage the growing film are of special interest.

In this contribution we report results of comparative analysis of ion energy distributions in a broad energy range for DC magnetron sputtering using metallic and ceramic targets. The energy distributions of low-energy ions show a similar behaviour for both processes, while in case of high-energy negative ions and fragments of them, they are substantially different . Moreover, magnetron plasma in case of metallic target sputtering shows substantially lower fraction of negatively charged ions with high energy. The observed differences indicate the potential of reactive magnetron sputtering to produce AZO films with less damage, and as a result, with improved properties.

DS 8.5 Mon 17:30 H 2032

Tantalum incorporation in TiO2 based transparent conductive thin films — •Marcel Neubert, Mykola Vinnichenko, Steffen Cornelius, and Andreas Kolitsch — HZDR

The growing number of applications of transparent electrodes in optoelectronic devices drives the need for novel cost-efficient transparent conductive materials. The epitaxial films of TiO2 doped with Nb or Ta show electrical resistivity values comparable to those of the best In2O3:Sn and ZnO:Al films. However, it is still challenging to achieve low electrical resistivity in polycrystalline TiO2-based films. In order to address this problem, we studied the films formed on glass substrates without heating by DC magnetron sputtering of reduced TiO2:Ta ceramic targets followed by vacuum annealing. It was crucial to use a plasma feedback system in order to enable a fine tuning of the oxygen supply into Ar and O2 gas mixture during the deposition. This approach yielded the 400 nm thick films with optical transmittance above 80%, electrical resistivity in the range of 10-3 *cm and free electron mobility of 8 cm*/Vs. The electrical activation of Ta dopant was above 60% that is substantially higher than that of Al in ZnO.

DS 8.6 Mon 17:45 H 2032

Ultra-short laser pulse structuring of thin zinc oxide layers on 30 cm x 30 cm CIS solar cell modules — •Christian Miller, Daniel Harangozo, Juergen Sotrop, Gerhard Heise, and Heinz Huber — Hochschule München, Laserzentrum, Lothstr. 34, 80335 München, Deutschland

In order to avoid resistive losses and for voltage transformation thin film solar cells must be separated into serially connected sub cells. In the case of CIS thin film solar cells the interconnection is performed in industry by ns-laser structuring and mechanical scribing, to separate the Molybdenum p-contact as well as the CIS-absorber and the Zink oxide n-contact, respectively. In contrast, ps-laser enables selective structuring of a specific layer, reducing the damage of the subjacent layer. For this purpose, we demonstrate an all-pico-second-laser process on 30 cm x 30 cm samples. Module efficiencies of 11.8 % where achieved reducing the width of the interconnection down to about 150 um.