MM 30: Topical Session Photovoltaic Materials I

Time: Wednesday 10:15–11:30 Location: H4

Topical Talk MM 30.1 Wed 10:15 H4

Solar cell absorbers made from rust ? - Stacked-Elemental-Layer-RTP and corrosion of alloys — •Rainer Hock, Roland Schurr, and Astrid Hölzing — University Erlangen-Nürnberg, Chair for Crystallography and Structural Physics, Staudtstraße 3, D-91058 Erlangen, Germany

Semiconducting absorber materials for thin film photovoltaics like $Cu(In,Ga)(S,Se)_2$ can be crystallised by heating thin metallic films in chalcogenide atmospheres. This process is known under the acronym SEL-RTP (Stacked Elemental Layer - Rapid Thermal Processing). In the initial stages of this process, the metallic films are attacked by sulfur, selenium or both, forming often a variety of metal chalcogenides. We had a 'second look' on the initial stage of SEL-RTP for the fabrication of absorber materials for thin film photovoltaic applications. This first step is the corrosion of the metal alloys in chalcogenide atmospheres. The different view on the fabrication process may allow to learn from a field of scientific research which was driven mainly by the oil and chemical industries in the second half of last century. At that time, the focus was directed on the search for corrosion resistant metal alloys for use in sulfur containing atmospheres or liquids. Through a reversed view, SEL-RTP may be seen as the desired and complete corrosion of thin metallic films. At the end of the corrosion process a polycrystalline thin film, monophase and with the desired material properties is hopefully produced. Controlled corrosion than leads to a functional, e.g. photovoltaically active thin film.

MM 30.2 Wed 10:45 H4

Amorphous / crystalline silicon heterojunctions: Changes of structural and electronic properties upon low-temperature annealing — •Hannes Ner Beushausen, Tim Ferdinand Schulze, and Lars Korte — Silicon Photovoltaics, Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany

Solar cells based on amorphous/crystalline silicon (a-Si:H/c-Si) heterojunctions have gained much attention due to their high conversion efficiency. In order to increase the open circuit voltage V_{oc} of these solar cells, the prime objective is to 'passivate' the a-Si:H/c-Si interface, i.e. to suppress interface recombination of photogenerated charge carriers by saturating recombination-active dangling bonds.

Commonly, thin (3-10nm) undoped, nominally intrinsic (i)a-Si:H interlayers are used to acheive this passivation effect. The presented work discusses the structural and electronic changes induced by low temperature post-deposition annealing of such (i)a-Si:H/c-Si structures.

The microscopic configuration of hydrogen in the thin amorphous layers, as probed by Fourier transform infrared spectroscopy (FTIRS), is linked to the improvement of the passivation and a dramatic increase of effective minority carrier lifetime τ_{eff}. With 10 nm thick undoped a-Si:H layers values up to $\tau_{eff} > 4.5$ ms, corresponding to interface recombination velocities S as low as 2 cm/s, were observed.

MM 30.3 Wed 11:00 H4

Rigorous optical simulation of rough interface light trapping structures in thin film silicon solar cells — •Daniel Lockau[1,2], Sven Burger[2,3], Lin Zschiedrich[2,3], Frank Schmidt[2,3], and Bernd Rech[1] — [1]Helmholtz–Zentrum Berlin, Berlin, Germany — [2]Zuse–Institut Berlin, Berlin, Germany — [3]JCMwave GmbH, Berlin, Germany

Thin film silicon solar cells suffer from the disadvantage of a low absorption coefficient of silicon in important spectral regions. In the case of a flat multilayer cell layout a considerable part of the incident light is reflected back out of the cell due to the low absorber thickness. It is therefore desirable to introduce scattering elements that prolong the average photon path length inside the solar cell's absorber. Rough interfaces between the layers of a solar cell have proven to provide efficient and industrially producible light trapping structures. As the scattering structures and the layer thicknesses are in the order of only a few ten wavelengths coherence effects have to be taken into account in the simulation and optimization of such structures.

We employ the finite element method for rigorous simulation of Maxwell's equations on 2D and 3D geometries to investigate light trapping effects produced by rough interfaces in thin film silicon solar cells. To approximate an extended rough surface we examine the influence of boundary conditions and a finite computational domain size on the absorption. We apply Monte Carlo sampling over sets of surface representations to obtain averaged measurement quantities. Simulations of 2– and 3–dimensional rough surface geometries are compared.

MM 30.4 Wed 11:15 H4

Optical and structural properties of MBE grown silicon nanodots for photovoltaic application — •Maurizio Roczen, Enno Malguth, Orman Gref, and Manfred Schmidt — Helmholtz-Zentrum Berlin, Berlin, Deutschland

Third generation Solar cells are aimed to exceed the Queisser-Shockley Limit of 30 % efficiency for single junction silicon solar cells by utilizing the quantum size effect (QSE). In theory, the bandgap of nanosized silicon structures (<5 nm) widens with decreasing size. A hetero emitter consisting of silicon nanodots embedded in a SiO_2 matrix could therefore serve as an energy selective contact allowing the extraction of high energy carriers before thermalization takes place. The SiO_2 matrix allows passivation of an adjacent c-Si absorber and of the nanodots themselves. To grow crystalline silicon nanostructures of the required size, amorphous silicon nano layers were deposited onto plasma oxidized Si-wafers and silica substrates by e-beam evaporation at ultra high vacuum. Annealing the samples above 620 °C leads to the formation of separate crystalline spheres. Both atomic force and scanning electron microscopy show a clear tendency of decreasing sphere size for thinner primal layers. Crystallinity is confirmed by Raman experiments. To observe the quantum size effect, absorption and photo luminescence measurements were carried out as well as surface photo voltage measurements to check the density of states at the interface. Recent results on doped nanodots are discussed.