MM 41: Topical Session Modern Atom Probe Tomography II - Functional Materials

Time: Wednesday 16:45–17:45 Location: H 0107

MM 41.1 Wed 16:45 H 0107

Impurity distributions in $Cu(In,Ga)Se_2$ thin-film solar cells studied by Atom Probe Tomography — •Ralf Schlesiger[1], Roland Würz[2], Jens Bastek[1], Katharina Hiepko[1], Nicolaas A. Stolwijk[1], and Guido Schmitz[1] — [1]Institute of Material Physics, Westf. Wilhelms-Universität Münster, Germany — [2]Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg, Germany

To improve and understand the benchmarks of polycrystalline thin-film solar cells based on the compound semiconductor $Cu(In,Ga)Se_2$, detailed knowledge of the atomic-scale distribution of minority impurities is desirable and can only be obtained by atom probe tomography. During the growth process of the absorber at about 600°C, diffusion of impurity atoms from the substrate through the Mo back contact into the absorber layer is observed, affecting the efficiency of the absorber layer. In this work atom probe measurements were carried out to analyse the distribution of Na, Fe and Cd impurities within the $Cu(In,Ga)Se_2$ absorber layer. Na was exclusively introduced during crystal growth, whereas Cd and Fe were diffused at temperatures below 550°C from the front side of as-grown CIGS layers. It is clearly resolved that Na is mostly localized in the grain boundaries. While Fe is homogeneously distributed in the grain volume, with no enrichment at the grain boundaries, Cd shows a slight segregation to the grain boundaries. Concerning the $Cu(In,Ga)Se_2$ constituents at the grain boundaries, a depletion was found for Cu, with a simultaneous enrichment of In and Se.

MM 41.2 Wed 17:00 H 0107

Exploring the internal interfaces at the atomic-scale in Cu(In,Ga)Se2 thin-films solar cells — •Oana Cojocaru-Mirédin[1], Pyuck-Pa Choi[1], Roland Wuerz[2], and Dierk Raabe[1] — [1]Max-Planck-Institut für Eisenforschung, Max-Planck-Str. 1, 40237 Düsseldorf, Germany — [2]Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg, Stuttgart, Germany

Cu(In,Ga)Se2 solar cells possess a high efficiency, despite the polycrystalline structure of the absorber layer. This is mainly due not only to the impurities diffusion from the soda-lime glass substrate inside the absorber layer, but also to the CdS/Cu(In,Ga)Se2 p-n junction. However, the recombination mechanism between the defects and the impurities at the internal interfaces remains far to be understood. This is due to a lack of information on local chemical changes across the internal interfaces at the nanoscale. In this work, the internal interfaces, CdS/Cu(In,Ga)Se2 interface and Cu(In,Ga)Se2 grain boundaries, were explored at atomic-scale by means of atom probe tomography. A Cu-depleted and Cd-doped region (~ 2 nm in width) was detected at the Cu(In,Ga)Se2 surface. It was also shown that Cd diffused through the Cu(In,Ga)Se2 grain boundaries during the deposition of CdS layer. The diffusion of Cd inside the Cu(In,Ga)Se2 grain, but also in the grain boundaries prove the existence of a buried p-n homojunction within the Cu(In,Ga)Se2 absorber layer. Regarding the Na (K) and O impurities, they were found to decorate not only the CdS/Cu(In,Ga)Se2 interface, but also the Cu(In,Ga)Se2 grain boundaries. The present results were compared with the existing electronic GB models.

MM 41.3 Wed 17:15 H 0107

Nanoanalysis of CoFeB electrodes in pseudo spin valve magnetic tunnel junction — •Houari Bouchikhaoui, Patrick Stender, Mohammed Reda Chellali, and Guido Schmitz — Institut für Materialphysik der WWU, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany

A magnetic tunnel junction (MTJ), which consists of a thin insulator layer sandwiched between two ferromagnetic electrode layers, exhibit tunnel magnetic resistance TMR due to spin-dependent electron tunnelling. The theoretical prediction of over 1000% TMR by the preferential tunnelling of $\Delta 1$ Bloch states in Fe/MgO/Fe magnetic tunnel junction led to the experimental demonstration of giant TMR about 150% at room temperature. The pseudo spin valve PSV MTJs $Ta/Co_{20}Fe_{60}B_{20}/MgO/Co_{20}Fe_{60}B_{20}/Ta$ has great interest due to high magnetoresistance TMR value at room temperature after annealing at elevated temperatures. In this work, we analysed the nanostructure and chemical distribution of constituent elements in $Ta/Co_{20}Fe_{60}B_{20}/MgO/Co_{20}Fe_{60}B_{20}/Ta$ PSV MTJs annealed between room temperature and 600C° by atom probe tomography (TAP). The segregation of Boron to the interfaces will be presented in dependence on temperature.

MM 41.4 Wed 17:30 H 0107

Atom Probe Tomography of ONO stacks for in-production flash memory — •Sebastian Koelling[1], Ahmed Shariq[1], and Sonja Richter[2] — [1]Fraunhofer Center Nanoelectronic Technologies, Königsbrücker Straße 180, 01099 Dresden, Germany — [2]X-FAB Dresden GmbH & Co. KG, Grenzstrasse 28, 01109 Dresden, Germany

The introduction of laser assisted Atom Probes with a wide angle detector systems made Atom Probe Tomography a highly interesting technique for routine analysis of semiconductor devices. While laser assisted Atom Probe analysis of bulk semiconductors like silicon or germanium is nowadays routinely possible, the analysis of insulating layers is still challenging even with the most recent generation of tools. As insulating oxide and nitride layers are an integral part of the gate of every transistor, we are working on overcoming this limitation. Here we will report on our progress in analyzing gate stacks for state-of-the art transistor structures. We will focus on (silicon-) oxynitride/oxide stacks used in present-day flash memory. These stacks are 10-20 nm thick and are particularly challenging to analyze due to their comparatively large thickness and the need for mapping the nitrogen content inside the layers. We will present ways to improve the yield when measuring these stacks and an approach to quantify the nitrogen in-spite of the mass overlap with silicon.