I. Physikalisches Institut (IA) Physik neuer Materialien
RWTH AACHEN UNIVERSITY

Nanocharacterization for Advanced Functional Materials
Dr. Mohit Raghuwanshi

Topic for a Master Thesis

Correlative microscopic investigations of multicrystalline Si solar cells

Multicrystalline Si (mc-Si) solar cells are currently the second largest type of material used in commercial solar cells only after crystalline Si (c-Si) solar cells. Our group has previously shown that c-Si have better efficiency than mc-Si mainly because of impurity segregation at the grain boundaries (GBs) in mc-Si. These defects mainly comprise of unwanted impurities like C, O and Cu, which diffuses and segregates at GBs during the mc-Si wafer production. mc-Si bricks is produced by melting of Si and its gradual cooling from bottom of the brick to the top, during this cooling process the grains of Si are formed and the impurities unavoidably diffuses at the GBs. The amount of impurities at GB hence varies along different part of the brick i.e. bottom, middle and top.

The main goal of this study is to understand how the electrical properties of GB changes with the depth in the mc-Si brick and how it is affected by the change in composition of the GB. Three mc-Si samples (at top, bottom and middle part of brick) have been prepared by the group of Prof. Markus Rinio at Karlstads University (Sweden). Micrograph of one of the sample from bottom part of the brick is shown in Figure 1 which represents an EBSD (electron back-scattered diffraction) (left) and the corresponding EBIC (electron beam induced current) map on right. The dark contrast in EBIC shows that the GB is detrimental is nature, which is typically observed for mc-Si, the corresponding EBSD map reveals the GB is a random angle GB. Using these techniques we can determine the exact location of the GB and estimate the electrical property (i.e. relatively how bad/good they are). However, we need an additional technique to know the composition of this GB. Atom probe tomography (APT) is now a well-recognized microscopic technique, which can detect solute atoms with high detection limit (10-30 ppm). Scanning electron microscopy equipped with focused ion beam (FIB) is used to prepare site-specific specimen preparation for APT. FIB will be used in this work to make specimen at these GBs (e.g. Figure 1) and these specimens can then be measured in APT to reveal the composition of this particular GB.

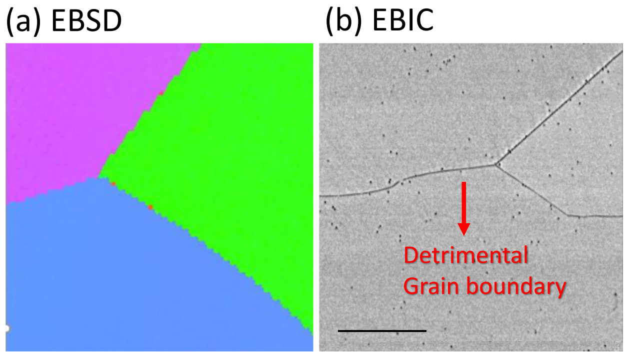

Figure 1: (a) EBSD (electron back-scattered diffraction) map of mc-Si and the corresponding (b) EBIC (electron beam induced current) map showing the location of a detrimental GB.

In this Master thesis we will investigate the properties and composition of these GBs from different samples of mc-Si. With this information we will understand which elements are particularly detrimental for GBs in mc-Si. Moreover, we will understand the diffusion process of impurities at different parts of the brick which can provide valuable information about which part of the brick is most useful for the device preparation.

Supervisor Dr. Mohit Raghuwanshi
✉ raghuwanshi@physik.rwth-aachen.de
MBP2_002 0241 / 80 20271