Simultaneous EBSD and EDS analyses on thin film stacks as typically used in solar cells

Felix Reinauer[1], R. de Kloe[1], D. Kraft[2], and H. Schulz[2]

1. EDAX Germany, Kreuzberger Ring 6, 65205 Wiesbaden, Germany
2. Carl Zeiss NTS GmbH, Carl-Zeiss Strasse 56, 73447 Oberkochen, Germany

h.schulz@smt.zeiss.com
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Electron Back Scatter Diffraction (EBSD) has proven to be a powerful surface sensitive analysis method for microstructural investigations (grain size, grain orientation, texture etc.) of crystalline materials. Meanwhile, it is widely used in Scanning Electron Microscopes (SEM) for acquiring 2D or even 3D EBSD maps using FIB-SEM instruments, the combination of a SEM and FIB column (Focused Ion Beam) in one tool.

As the conversion efficiency of a thin film solar cell such as CdTe strongly relies on the properties of its individual layers EBSD analyses provide essential information for a correlation of the microstructure and the electrical cell behavior. Thin film solar cell samples such as CdTe prepared by conventional mechanical procedures like cleaving or grinding are not optimal for EBSD due to their rough surfaces or smearing artefacts, respectively. By contrast, Focus Ion Beam (FIB) techniques are able to in-situ produce clean and flat cross-sections enabling the acquisition of high-quality EBSD patterns.

EBSD investigations may occasionally have limitations, for instance in case of layer stacks with similar materials in terms of lattice structure. As shown in Fig.1 the EBSD pattern of a CdTe film can also be indexed as gold (Au) or indium oxide (In_2O_3). Both layers are typically used in CdTe thin film solar cells as well. This restriction can be overcome by considering simultaneously acquired EDS (Energy Dispersive Spectrometry) data for the phase or layer determination. Furthermore, the EDS data can be used for gaining information about the spatial distribution of particular elements in thin films or bulk materials [1].

Benefits of the combined EBSD/EDS technique in a FIB-SEM instrument:

- In-situ preparation of clean (no contaminations or surface oxidation) and flat cross-sections.
- Consideration of both the chemical composition data (EDS) and the crystallo-graphic structure information (EBSD) for an unambiguous phase or layer determination (ChI-scans).
- The combined EBSD/EDS technique is a powerful method for gaining a deep understanding of the microstructural and compositional material properties [2].

The authors will present EBSD/EDS analysis results of differently manufactured CdTe thin film solar cells.

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2. R. de Kloe (2008): “Advances in 3-dimensional material characterization using simultaneous EDS and EBSD analysis in a combined FIB-SEM microscope, 14th European Microscopy Congress, Sep 2008, Aachen, Germany, pp 675-676.

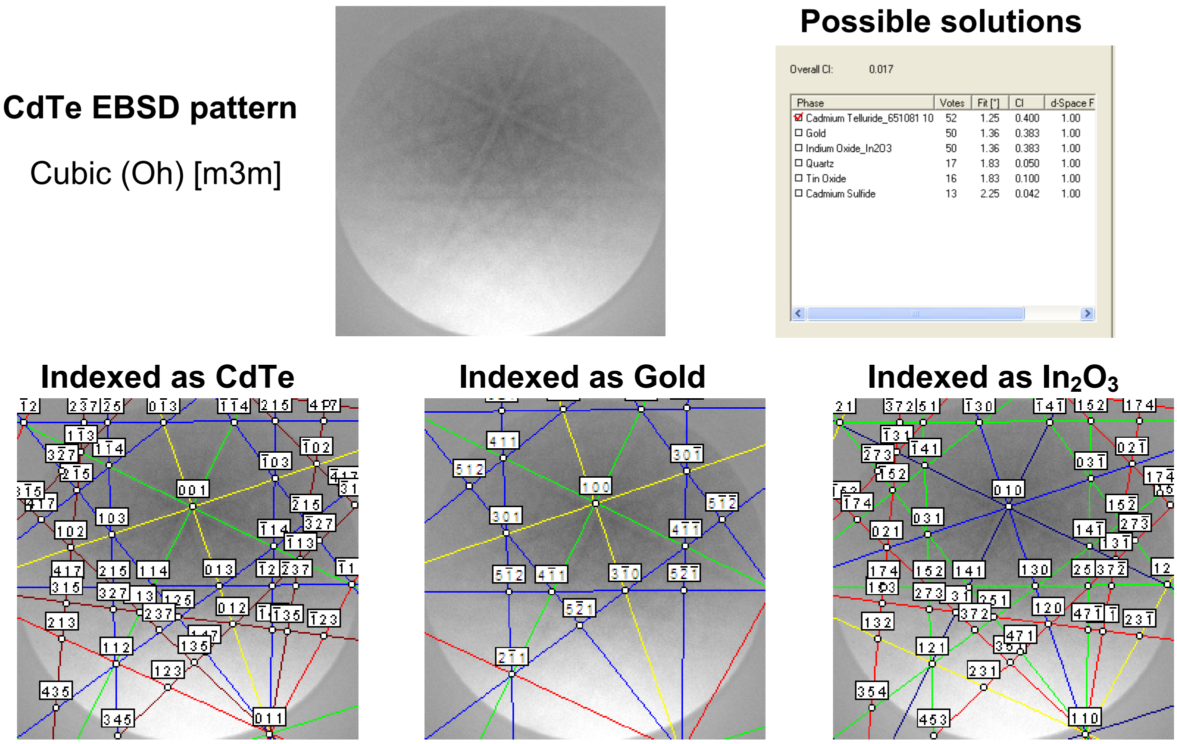

Figure 1: EBSD patterns of the CdTe layer in a thin film solar cell sample. The CdTe pattern could also be indexed as gold or indium oxide. An unambiguous layer distinction based on the EBSD data is therefore not possible, additional chemical information are therefore required.

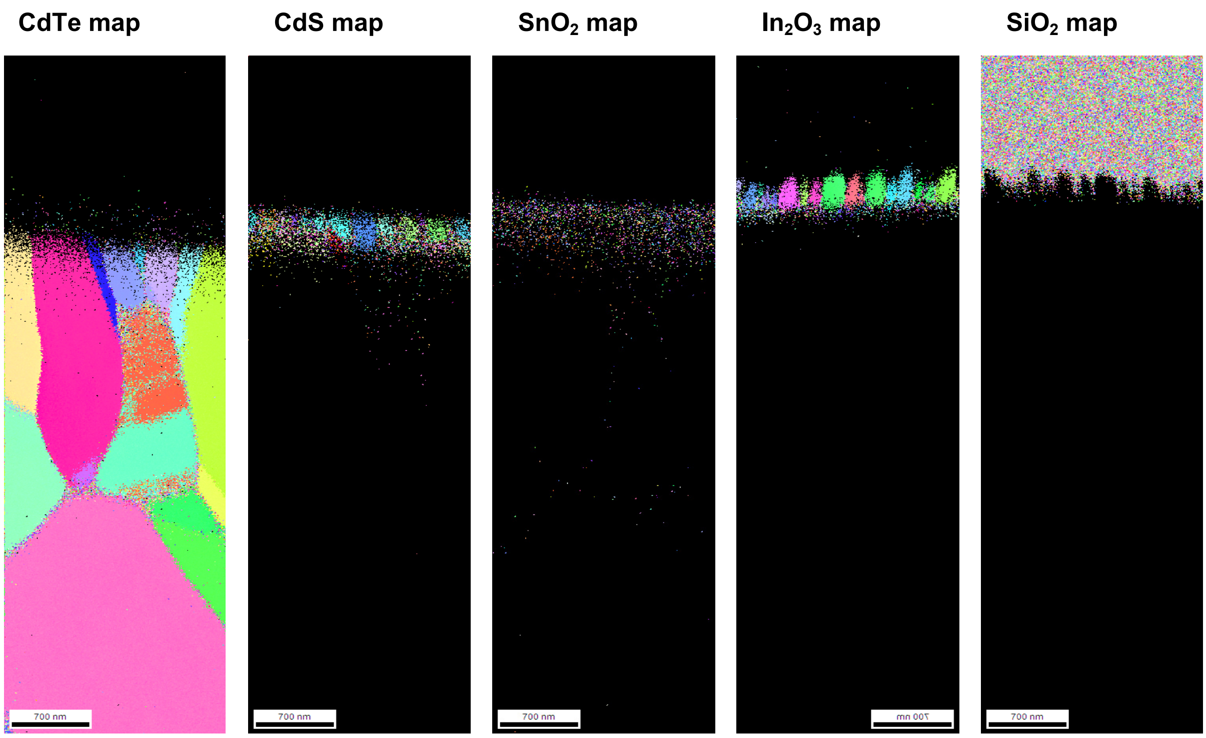

Figure 2: ChI-scan results of a CdTe thin film solar cell sample. Based on the combination of EBSD and EDS data a clear differentiation of the individual layers is possible. The maps provide microstructural information about the various films, e.g. grain size and orientation.

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