Combined Scattering and Fluorescence Mapping of Kesterite Precursors at the NanoMAX Beamline

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Abstract: Materials with the approximate stoichiometry Cu2ZnSnS4, with the crystal structure of the mineral kesterite are currently being investigated as promising materials for thin film solar cells fabrication. Direct imaging, along with chemical analysis, can crucially contribute to assess the quality of the process. This poster presents the results from the obtained fluorescence and scattering maps from a sample of kesterite precursors obtained by pulsed laser deposition (PLD). The obtained chemical information was compared with energy dispersive spectroscopy (EDS) measurements previously made on the same sample.

Introduction: Third-generation photovoltaic solar cells are currently under research and development as an attractive technology for cheap and efficient solar energy conversion. This new type of solar cells is characterized by its design (thin films) and by the use of nontoxic and Earth-abundant materials with a potential significant decrease in energy payback time when compared to common silicon-based solar cells. Kesterite photovoltaics utilizing Cu2ZnSnS4 (CZTS) are one of the promising emerging technologies that have already demonstrated a high absorption coefficient (107 cm-1) and a direct band gap of 1.1-1.5 eV which allows an effective energy absorption in absorber layers of a few microns. One of the main challenges during the synthesis of CZTS is related with formation of different secondary phases that compromise the operation of this material as a photovoltaic cell. The phase diagram below exhibits the narrow confined conditions for the synthesis of the desired Cu2ZnSnS4 phase.

A good understanding of different synthesis methods is therefore essential in order to control the optimal conditions for kesterite formation and improve future thin-films kesterite solar cells.

Sample Preparation: A thin film sample of kesterite precursors (2Cu:Zn:Sn:S:5S) was prepared with pulsed laser deposition (PLD) on a soda-lime glass substrate intercalated with a thin Molybdenum layer.

Experimental Setup: We acquired both fluorescence and scattering maps from a thin film CZTS sample, illuminated by an 10.72 keV X-ray beam at the NanoMAX beamline.

Data analysis: The acquired fluorescence spectra were processed with PyMca, a dedicated software developed in the European Synchrotron Radiation Facility (ESRF).

Results: The obtained results allow the identification of several inhomogeneities in the kesterite precursors deposition. The measured stoichiometric ratio between Cu and Zn was found to be in agreement with previous EDS measurements.

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