Status of the P02.1 RF-Magnetron Sputtering Chamber for in situ Investigation of Thin Film Growth

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There has been an ever increasing demand on tailoring the properties of thin film ferroelectric materials for the needs of the semiconductor industry ever since. This kind of deposition control requires a deep understanding of the processes involved in sputtering of thin films which can be best accomplished via in situ time resolved X-ray powder diffraction. For this reason DESY started a collaboration with the Department of Physics at the RWTH Aachen University in form of a PhD project. The PhD project of the report’s first author “Real time investigation of thin layer growth in sputter deposition processes” started on the 1st of April 2012.

The first goal of the project is to build an in situ sputtering chamber at the High Resolution Powder Diffraction beamline P02.1 for in situ X-ray diffraction to determine the influence of the processing parameters on nucleation, crystallisation, and microstructure evolution during film growth. This fundamental knowledge is necessary to systematically control the composition, the morphology, and the resulting electrical properties of the layers for specific industrial applications. In order to investigate thin films using the full capabilities of the P02.1 beamline [3] the online sputtering chamber has to be mounted on the existing high resolution powder diffractometer. Therefore the size and height of the unit have to be minimized without limiting the performance of the sputtering process. The unit is designed for a base pressure of $10^{-8}$ mbar and deposition rates from 1 Å/min to 100 Å/min. Sample heating up to 1000°C will be realised by an electron beam heater. The first material system to be investigated will be Barium Titanate (BaTiO₃) [1, 2].

![Fig. 1: very first Plasma light of the P02.1 sputter gun taken on the 16th of March 2013](image)

The sputter chamber setup is designed as a highly flexible tool to be used at different experiments. Therefore the smallest base unit has a weight of 22kg and the minimum outer dimensions are (200x400x250) mm³ (see Fig. 2). For experiments at the P02.1 beamline the setup has a weight of 28kg and outer dimensions of (200x555x260) mm³. To simplify the change of substrate an automated substrate magazine will be developed. Furthermore, the chamber is designed to allow integration into the MBE analysis chamber of the P08 beamline.

The design phase is completed, all parts are supplied, the chamber is assembled and first tests at the P02.1 beamline have been successfully completed (see Fig. 3). The first in situ beam time is scheduled for middle of 2013.
Fig. 2: outer dimensions of the sputter chamber

Fig. 3: chamber mounted on the P02.1 diffractiometer

References