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Crystallographic phase and orientation mapping of ferroelectric HfO_2 thin films by transmission Kikuchi diffraction

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Abstract

Since the discovery of ferroelectricity in HfO_2 thin films [1], it obtained great research interest for the implementation into various integrated devices e.g. non-volatile memories or infrared sensors, due to its CMOS compatibility. As the ferroelectricity in HfO_2 is assigned to the orthorhombic $Pca2_1$ phase [2], its phase fraction and orientation have a strong influence on the ferroelectric properties of the polycrystalline thin film. Due to the similar x-ray diffraction (XRD) pattern of the tetragonal and cubic phase, XRD analysis of the orthorhombic phase is strongly limited.

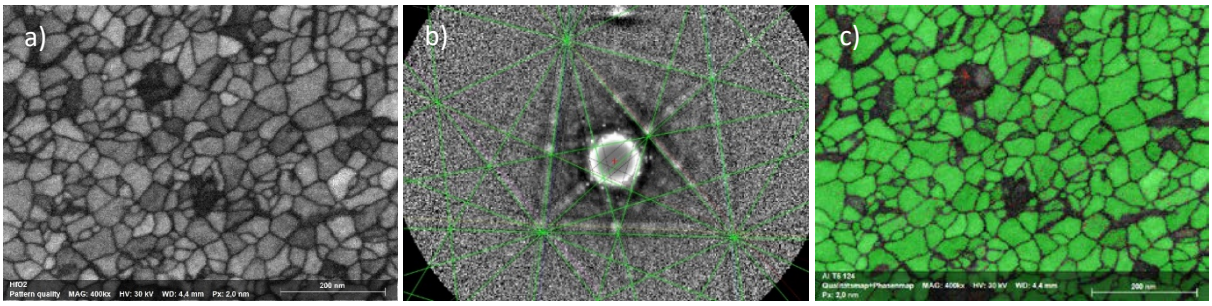

Figure 1. Phase identification of HfO_2 by TKD. From the EBSD pattern contrast of each point, a quality map (a) can be constructed. By comparing the EBSD patterns with simulated patterns from given phases (b), the phase can be identified and a phase map (c) can be constructed.

Transmission Kikuchi diffraction (TKD) using a scanning electron microscope (SEM) is used for orientation mapping of nanostructured metals and is suggested to become an important technique for the characterization of nanocrystalline structures [3]. Here, we report the TKD analysis of Zr-doped HfO_2 thin films. Therefore, the measured electron diffraction of dimpled samples are transformed into the Hough space and compared with the phases of HfO_2 (see figure 1). This allows the mapping of the crystallographic phase and grain orientation which indicates a strong out-of-plane texture of the orthorhombic phase.

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