MS43-O2 Depth-dependent evolution of texture and stress in thin films

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Modern technological devices to a large extent rely on polycrystalline thin films [1]. This holds for instance for integrated circuits from the semiconductor industry, sensoric and optical layers to mention only a few examples. Often, polycrystalline films exhibit pronounced gradients, i.e. depth-dependent evolutions of fiber texture and residual stress [2]. These phenomena are, for instance, highly relevant for wurtzite-structured thin films composed of ZnO or AlN that are currently under development for fully CMOS integrated surface acoustic wave (SAW) devices for biomolecular sensing applications, see Fig. 1 from Ref. [3]. It will be shown how a fiber texture gradient may be modeled in kinematical x-ray diffraction and which effect it has on the intensity mapping of the fiber Bragg reflection I_{HKL} in tilt angle y scans [4]. The formalism presented makes use of the μt product from the linear attenuation coefficient μ and film thickness t. If the increase of fiber texture degree per unit thickness is given by n_1 it is found that the measured intensity distributions $I_{HKL}(y)$ sensitively depend on the n_1/μ ratio. The formalism is demonstrated by synchrotron-based investigations of ZnO layers, for which the texture gradient was determined by a technique that relies on the variation of the x-ray wavelength [5]. As an example for the significance of residual stresses the preparation of 50 nm thin TiN layers is presented that are intended for mechanical applications in microelectromechanical systems (MEMS) [6]. In this case, tensile strains had to be introduced into suspended layers in order to operate them as bendable beam excited in a quasi-electrostatic operation mode.

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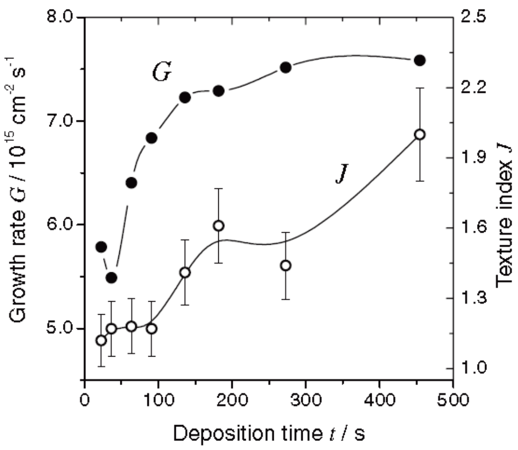

Fig. 1. Growth rate G derived from atomic areal density measurements (left ordinate) and texture index J (right ordinate) for a set of ZnO:Al samples as a function of deposition time t. Growth rate G and texture index J are seen to increase concomitantly.

Figure 1.

Keywords: thin film, texture, residual stress, depth gradients