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ANISOTROPIC SIZE BROADENING ANALYSIS OF TEXTURED NANOCRYSTALLINE SILICON THIN FILMS PROBED BY X-RAY DIFFRACTION

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Nanocrystalline silicon thin films are challenging materials for large scale microelectronics prepared at low temperature processing. However their complete microstructural and structural characterisation is a hard task, mainly because of their thin structure and the simultaneous appearance of texture, cell parameters and anisotropic crystal shapes. We used in this work a newly developed X-ray technique which is able to combine quantitatively the texture, structure and anisotropic shape determination. Silicon films were grown by reactive magnetron sputtering in a plasma mixture of H_2 and Ar around 200°C, for controlled target to substrate distances, on amorphous SiO_2 and single-crystal (100)-Si substrates. Films were measured using four-circle diffractometry and a curved position sensitive detector.

Whatever the substrate used, preferred orientations are observed with texture strengths around 2 to 3 times a random distribution, with a tendency to achieve lower strengths for films grown on SiO_2 substrates. A strong anisotropic broadening of the diffracted lines is observed due to anisotropic shapes of individual crystallites. Anisotropic shapes and textures are strongly correlated with, as a global trend, longest crystallite sizes along the <hkl> direction of the texture. Cell parameters change both with the stabilised orientation and the crystallite size, and are always refined larger than the value for bulk silicon, by around 0.005 to 0.015 Angstroms.