E-beam evaporation vs. rf-sputtering: Comparing the growth behavior, crystallinity, and morphology of heteroepitaxial iridium (001) films on sapphire (11-20)

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Many characteristics of the metallic surface i.e. the electronic structure, surface energy, and catalytic activity, strongly depend on the crystallographic orientation. To control and define the crystallographic orientation of a metallic surface is thus important in applications ranging from electronic device fabrication to catalysis. (100)-oriented iridium films are of economic interest for the growth of single crystalline diamond substrates or ferroelectric PZT-films [1]. A possible synthetization route is the heteroepitaxial growth of iridium thin films on single crystal oxides. This is often done by e-beam-evaporation [2] at high substrate temperatures (> 600 °C-800°C) and low deposition rates (< 1nm/min). However, regarding e.g. industrial production processes, an alternative deposition technique with significantly lower substrate temperatures and higher deposition rates would be desirable. When compared to e-beam-evaporation, it is expected that e.g. sputtering allows for an enhanced control of microstructure and intrinsic stresses in the deposited films even at relatively low substrate temperatures but also leads to a higher number of growth defects. In this study we therefore compared the growth behavior, crystallinity, and morphology of e-beam evaporated iridium films with bias assisted rf-sputtered iridium films. For e-beam-deposition, we varied the substrate temperature and the evaporation rate, for sputtering, we varied also the substrate temperature, the deposition power and working pressure. XRD revealed in both cases a strong preferential (100)-orientation whereas SEM and EBSD-investigations confirmed large (100)-grains with small mosaic spread.


Keywords
Bias-assisted rf-sputtering
e-beam evaporation
growth behavior