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Properties of TiO2 thin films grown by reactive ion beam sputter deposition

Thomas Lautenschläger, Carsten Bundesmann, Erik Thelander, Daniel Spemann

Institut für Oberflächenmodifizierung, Leipzig, Germany

thomas.lautenschlaeger@iom-leipzig.de

Ion beam sputter deposition is a versatile technique for tailoring thin film properties as it provides the opportunity to vary the properties of the film-forming, secondary particles. This is possible because the place of generation of primary particles (ion beam source) and secondary, sputtered and backscattered particles (target), and thin film growth (substrate) are locally separated. Hence, by changing ion beam parameters (ion energy, ion species) and geometrical parameters (ion incidence angle) the angular and energy distribution of the secondary particles is changed, which leads to a change of thin film properties.
TiO_2 films were deposited by reactive ion beam sputter deposition under systematic variation of ion beam and geometrical parameters. The films were characterized concerning thickness, growth rate, structural properties, mass density, composition and optical properties. Film thickness and growth rate show an over-cosine angular distribution that is tilted in forward direction. The growth rate was found to increase with increasing ion energy and ion incidence angle, which can be explained by the known dependence of the sputter yield. The TiO_2 films are amorphous and show systematic variations in the optical properties. The index of refraction was found to be influenced mainly by the scattering geometry, i.e. by the scattering angle. However, reducing ion energy or ion incidence angle, results in a considerable lower index of refraction. The index of refraction can be influenced by the stoichiometry or the mass density. All films were found to be stoichiometric, but a strong correlation of the index of refraction with the mass density could be revealed. The systematic variation of the index of refraction and mass density is tentatively assigned to the influence of the backscattered primary particles, because a considerable amount of primary particles was found in the films.

Keywords
reactive sputtering
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