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Options to Tailor Thin Film Properties by Ion Beam Sputter Deposition

Carsten Bundesmann, Thomas Lautenschläger, René Feder, Daniel Spemann

Leibniz Institut of Surface Engineering, Leipzig, Germany

carsten.bundesmann@iom-leipzig.de

There is an increasing demand for thin films with optimized properties. This requires the use and control of adequate deposition techniques. Ion beam sputter deposition (IBSD) is capable to fulfil the technological demand, because it offers the unique opportunity to tailor the properties of the film-forming particles and, hence, thin film properties. This is related to the fact that the generation and acceleration of the primary particles (ion source), the generation of the film-forming particles (target) and film growth (substrate) are spatially separated. Thus, by changing ion beam parameters (ion species, ion energy) and geometrical parameters (ion incidence angle), the angular and the energy distribution of the sputtered target particles and backscattered primary particles are modified.
Systematic investigations of the correlation of process parameters, the properties of the sputtered and backscattered particles, and thin film properties were performed. Exemplary, three materials were used: Ge (semiconductor), Ag (metal) and TiO_2 (dielectric). Though the materials are very different, the fundamental systematics were found to be the same. It could be shown that (i) the most important parameters are the scattering geometry and the primary ion species, or more precisely the mass of the primary particles in relation to the mass of the target particles, (ii) ion energy and ion incidence angle have only a small or negligible impact, (iii) backscattered primary particles have a higher impact on thin film properties than the sputtered target particles.
The results are illustrated by selected examples of the IBSD process of Ag and TiO_2. The influence of the process parameters on the energy distribution of the film-forming particle and on the thin film properties, such as, structural properties, composition, surface roughness, mass density, electrical or optical properties are shown.

Keywords
Ion beam sputter deposition
Film properties
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Silver (Ag)
Titanium dioxide (TiO2)