Temperature – induced tuning of chemical and electron properties in low-cost alumina thin layers

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Aluminium oxide has been widely investigated and applied since a century however lately it is attracting emerging interest in modern technologies. As a thin layers, alumina is currently being applied in a vast range of applications i.e. molecular separation, energy generation and storage, microelectronics, (bio)sensors, optical devices, protective and anticorrosive coatings. For successful implementation, detailed knowledge on the electron and chemical properties, structural defects and their mutual relation have to be known.

In this work, we show how to tune the chemical, electron and structural properties by post-deposition temperature treatment. For this purpose, the alumina thin layers were prepared by the sol-gel method followed by spin-coating deposition. Then, the layers were annealed at different temperatures for basic properties differentiation. For the most comprehensive description, we combined the experimental data received from photoelectron spectroscopies (X-ray photoelectron spectroscopy and ultraviolet photoelectron spectroscopy) with density-functional calculation while the surface topography and morphology were checked with scanning probe microscopies and X-ray diffraction.

Our research shows that the post-deposition processing temperature impact on the chemical and electronic structure is mainly revealed in stoichiometry changes and presence of deep defect states (mostly oxygen vacancies) in the band gap in the vicinity of valence band onset. Finally, we do show that the temperature impact is systematic, which enables proposed thin film treatment to be applied to tune the layers' properties towards desired application.

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