

L. Rabisch: *Eu-doped sesquioxide ultra-thin films deposited by thermal evaporation on α -Al₂O₃ substrates*

In the course of this work Eu:Y₂O₃ and Eu:(Lu_{0,19}Sc_{0,81})₂O₃ thin films were grown on (0001)-surfaces of α -Al₂O₃-substrates using electron-beam evaporation (EBV) and ion assisted deposition (IAD) technique. The thickness of the films ranges between 3.6 nm and 3.7 μ m. The europium concentration is about 3.5 %_{mol}.

Y₂O₃ films deposited by EBV consist of polycrystalline α -Y₂O₃ with little admixture of β -Y₂O₃. The packing density is in the order of 0.86 and the average size of the α -Y₂O₃-domains is 27 nm at most. The local symmetry of the α -Y₂O₃ domains is equivalent to the symmetry of the bulk crystal as long as the average film thickness exceeds some 10 nanometers. Effects associated with the surface or grain boundaries reduce the quantum yield of the Eu³⁺-fluorescence considerably compared with films deposited by PLD. The samples were found to become dull within six month after preparation. This is attributed to formation of an amorphous hydroxide phase.

(Lu/Sc)₂O₃-films are chemically stable. The lattice mismatch to the substrate is -1,5 % whereas it is 4,7 % for α -Y₂O₃. This leads to films textured along the $\langle 111 \rangle$ direction. The grains tend to follow the guidelines of the substrate by being oriented around the surface normal. The grain size and quantum yield of the fluorescence is considerably larger than in Y₂O₃-films of similar thickness. The local symmetry of the Eu³⁺-centers is identical to the symmetry in (Lu/Sc)₂O₃ bulk crystals. Spectral modifications due to surface effects dominate only when the average film thickness is about 5 nm or less.

The structural properties of Eu:Y₂O₃-films deposited by IAD resemble those deposited by EBV – particularly with regard to the small-scale grain size and low quantum efficiency of fluorescence. However, the formation of β -Y₂O₃ was efficiently suppressed by the use of an O-ion beam.

The crystal structure of Y₂O₃- and (Lu/Sc)₂O₃-films on Al₂O₃-substrates cannot be improved by post deposition annealing. Before the necessary temperature to improve the film quality is reached Al-ion diffusion occurs, which leads to the formation of polycrystalline Y₃Al₅O₁₂ and Lu₃(Sc/Al)₅O₁₂, respectively.