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Surface roughness evolution of silica dioxide thin film grown on polymeric foil by Atmospheric Pressure PECVD

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The understanding of the growth mechanism of thin films is of paramount importance for an effective control and precise prediction of thin film characteristics such as surface roughness and porosity. The growth front evolution of silica-like thin films deposited in a high current dielectric barrier discharge was investigated using Atomic Force Microscopy subsequently analysed by means of the scaling behaviour of the surface roughness evolution. The surface height profile, obtained from AFM, can be characterised within the scaling theory by the roughness (H) and growth (β)exponents which gives a unique relations between pairs of (H, β) exponents and the type of growth mode.
The set of SiO_2 films was grown in an AP-PECVD reactor with parallel bi-axial cylindrical electrode geometry on PEN foil. TEOS was used as a precursor for silica-like thin films and the process gasses were argon, nitrogen and oxygen. The Dynamic Deposition Rate (DDR) defined as the product of web speed and film thickness was approximately 10 nm m/min [1].The statistical analysis of the AFM data reveals three different regions in the film development. With increasing film thickness, the surface evolves gradually from a fine “rice”-like structure originating from the pristine PEN to a smooth surface with and constant . On further stages of surface morphology evolution there is a transition to large hill-like network, exhibiting film growth both in vertical and lateral direction. As a result, there is a transition in the roughness development at the critical thickness ofwith calculated growth exponent appeared to be equal β=0.66.
AP PECVD process showed to have a unique scaling behaviour unlike any of the existent universal classes reported so far. In the present study of the deposition mechanisms and growth front roughness evolution of SiO2 films, we observed the complexity of surface evolution, in particular, transition between smooth to the rough surface.
[1] S.A. Starostin, M. Creatore, J.B. Bouwstra, M.C.M. van de Sanden and H.W. de Vries, Plasma Process. Polym. 2015, 12, 545.

Keywords
AP-PECVD
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