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Effect of varying low substrate temperature on sputtered aluminium films

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Abstract

Aluminium thin films were sputtered on stainless steels at substrate temperatures (T_{sub}) varying between 44.5 °C and 100 °C and at a constant power of 200 W. At low temperatures, field emission scanning electron microscopy (FESEM) showed amorphous and porous films whereas at high temperatures the films exhibited dense, large-sized and interconnected structures. The porosity area fraction decreased from 8.3% to 1.3% as substrate temperature (T_{sub}) increased from 44.5 °C to 100 °C. The atomic force microscopy (AFM) analysis revealed distinct surface structures at higher T_{sub}. The average fractal dimension (D) increased with substrate temperature (T_{sub}). The Minkowski connectivity showed that the structure consists of highly interconnected structures. The highest hardness values and elastic modulus were recorded at 44.5 °C whereas the lowest values were obtained at 80 °C. The hardness and elastic modulus were strongly shown to depend on the contact depth of the indenter and exhibited smooth creep curve behaviour. These results imply that varying low substrate (T_{sub}) (even below 30% of melting temperature) influences the Al thin film deposition.