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Aluminum Oxynitride Thin Films Deposited by R-CFDCMS

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Oxygen (O) incorporation into aluminum nitride (AlN) thin films provides a wide variability to prepare transparent, hard and wear resistant coatings. The O-induced flexibility in physical parameters such as residual stress state or crystallinity allows for an expansion of the already broad application field of AlN by ternary Al-O-N, e.g. through oxidation-resistant protection coatings.
The technique applied in this study to deposit Al-O-N thin films of approximately 1 µm for the presented data is magnetically unbalanced reactive closed field direct current magnetron sputtering (R-CFDCMS). O contents are adjusted via the O_2/N_2 flow ratio in the reactive gas mixture. Up to 8 at% O was found to be built into the wurtzite AlN crystallites in the form of a solid solution. Films in this O concentration regime experience gradual crystal lattice shrinkage due to Al vacancies as well as grain refinement caused by enhanced repeated nucleation. Above the O solubility limit and below 16 at% O, an amorphous intergranular aluminum oxide (Al_2O_3) tissue envelopes the crystallites. In this regime the tensile stress state allows for water absorption, so that hydrogen (H) incorporation, supposedly into the Al_2O_3 tissue, is observed. Upon exceeding the limit of 16 at% O, X-ray amorphous coatings under compressive residual stress are formed, so that no H absorption is permitted anymore. N-O interactions were observed between 40-55 at% O, indicating the formation of an amorphous Al-O network containing small amounts of dissolved N. Al-O-N coatings, which gradually evolve from O-doped, crystalline AlN towards N-doped, amorphous Al_2O_3 upon increasing O content, render it possible to fabricate films with specific required properties tied to the intrinsic O content.

Keywords
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