Atomic Layer Deposition, Mechanical Properties and Wear Resistance of Ternary $(Cr_{1-x}Al_x)_2O_3$ Films.

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The complex materials including doped and ternary compounds have received considerable attention in the last decades due to the exhibition of superior mechanical, optical, and electrical properties compared to their binary counterparts. Chromium oxide ceramic material is technologically considered an important engineering material due to its corrosion, wear resistance, and high mechanical hardness [1-3]. This study presents the growth, mechanical (hardness and elastic modulus), and wear resistance of Cr_2O_3, and chromium- aluminum oxide ($(Cr_{1-x}Al_x)_2O_3$) films deposited via the atomic layer deposition method on Si substrates at a deposition temperature of 275 °C. Cr_2O_3 exhibited a crystalline microstructure containing the α-Cr_2O_3 eskolaite phase. HRSTEM analysis confirmed the presence of nanocrystallites in the ternary films. The hardness, elastic modulus, and wear resistance of the films were measured using nanoindentation on Hysitron Triboindenter by Berkovich-type diamond tip. The ternary compound films showed higher hardness due to an amorphous/crystalline nanocomposite structure and showed an 80% improvement in wear resistance compared with Cr_2O_3 films. By annealing up to 900°C, a transition layer with a 2.8 g/cm³ density formed in Cr_2O_3 films, which was nearly absent in ternary films, indicating their superior oxygen diffusion barrier properties.

The research was funded by Estonian Research Council (grants PSG448, PRG753, ETF9088) and the Centre of Excellence in Sustainable Green Hydrogen and Energy Technologies (grant TK210U5).

References

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