ALD-assisted Hybrid Processes for improved Corrosion Resistance of Hard coatings

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초 록 : Recently, high power impulse magnetron sputtering (HIPIMS) has attracted considerable attentions due to its high potential for industrial applications. By pulsing the sputtering target with high power density and short duration pulses, a high plasma density and high ionization of the sputtered species can be obtained. HIPIMS has exhibited several merits such as increased coating density, good adhesion, microparticle-free and smooth surface, which make the HIPIMS technique desirable for synthesizing hard coatings. However, hard coatings present intrinsic defects (columnar structures, pinholes, pores, discontinuities) which can affect the corrosion behavior, especially when substrates are active alloys like steel or in a wear-corrosion process. Atomic layer deposition (ALD), a CVD derived method with a broad spectrum of applications, has shown great potential for corrosion protection of high-precision metallic parts or systems. In ALD deposition, the growth proceeds through cyclic repetition of self-limiting surface reactions, which leads to the thin films possess high quality, low defect density, uniformity, low-temperature processing and exquisite thickness control. These merits make ALD an ideal candidate for the fabrication of excellent oxide barrier layer which can block the pinhole and other defects left in the coating structure to improve the corrosion protection of hard coatings.

In this work, CrN/Al2O3/CrN multilayered coatings were synthesized by a hybrid process of HIPIMS and ALD techniques, aiming to improve the CrN hard coating properties. The influence of the Al2O3 interlayer addition, the thickness and intercalation position of the Al2O3 layer in the coatings on the microstructure, surface roughness, mechanical properties and corrosion behaviors were investigated. The results indicated that the dense Al2O3 interlayer addition by ALD lead to a significant decrease of the average grain size and surface roughness and greatly improved the mechanical properties and corrosion resistance of the CrN coatings. The thickness increase of the Al2O3 layer and intercalation position change to near the coating surface resulted in improved mechanical properties and corrosion resistance. The mechanism can be explained by that the dense Al2O3 interlayer acted as an excellent barrier for dislocation motion and diffusion of the corrosive substance.