Phase stability and mechanical characteristics of sputtering (Mo, Hf)N coatings

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Abstract

This work focused on microstructure and mechanical property evolution of (Mo, Hf)N coatings in terms of input power modulation and annealing temperature. The influence of input power and annealing on composition, phase, hardness, modulus, and tribological behavior was discussed. The MoN, HfN, and (Mo, Hf)N films were fabricated through radio frequency reactive magnetron sputtering at a fixed Ar/N_2 inlet gas ratio of 12/8 sccm/sccm. For MoN and HfN films, the input power on Mo and Hf targets were both set at 150W. As for (Mo, Hf)N coatings, the input power modulation was set as 150W and 25 to 200W. The vacuum annealing was performed at 500 and 650°C for 1 hr, followed by the furnace-cooling to room temperature. The structure of MoN film exhibited B1-MoN, γ-Mo_2N, and MoN_2 phases, while the HfN film existed δ-HfN and c-Hf_3N_4 phases. The Hf contents in (Mo, Hf)N coatings increased linearly from 0 to 12.8 at.% with input power rose. When Hf was below 5.6 at.%, a polycrystalline microstructure with δ-HfN, B1-MoN, β-Mo_2N, γ-Mo_2N and MoN_2 phases were identified. According to nano-indentation, scratch and wear test results, the best combination in mechanical characteristics of (Mo, Hf)N film were observed when input power ratio of Mo/Hf was set as 150/100W. The coating exhibited a highest hardness of 22.5 GPa and presented a least wear damage. The vacuum annealing effect on multiphase feature and grain recrystallizing was discussed. The dense structure, excellent adhesion and superior tribological behavior of the nitride films owing to multiphase strengthening and solid-solutioning were anticipated.

Keywords: Microstructure; (Mo, Hf)N; Input power; Annealing; tribological behavior