The phase transformation and mechanical properties of magnetron co-sputtering (MoHf)N coatings through heat treatment

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Abstract

In this study, the influence of heat treatment temperatures on microstructure and mechanical properties of the magnetron co-sputtering (MoHf)N coatings were investigated. The relationships between phase, hardness, modulus, and tribological behavior were analyzed. The (MoHf)N films were fabricated at a fixed Ar/N_2 inlet ratio of 12/8 sccm/sccm and 350°C with tunning of the Hf target input power. Three (MoHf)N thin films of Hf variation co-deposition at 2.3, 7.4 and 10.2at% were produced and compared. The vacuum annealing was conducted at 500, 650, and 750°C for 1 hr. The as-deposited (MoHf)N binary nitride coatings exhibited polycrystalline microstructure with B1-MoN, γ-Mo_2N, and β-Mo_2N multiple phases. After 750°C vacuum annealing, increase in hardness from 20.1 to 28.4GPa was obtained. Similarly, the H^3/E^2 increased from 0.163 to 0.298, and the H/E ratio also increased from 0.1 to 0.102. The wear rate was reduced from 201.0 to 112.6 $\mu m^3/Nm$. The microstructure of (MoHf)N binary nitride coatings did not evolve significantly, however the mechanical behavior become stronger after vacuum annealing, meaning (MoHf)N coatings exhibited a great resistance to elevated temperature environment.

Keywords: Heat treatment; Microstructure; (MoHf)N; Multiple phase; wear resistance