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Crystal structure and the improvement of the mechanical and tribological properties of tungsten nitride films by addition of titanium

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Abstract: Tungsten titanium nitride films were synthesized by the reactive magnetron sputtering system and the influence of titanium content on the crystal structure, mechanical and tribological properties of the films were investigated. The results showed that the tungsten titanium nitride films at<6.7 at.% titanium were substitution solid solution of $(W_{1-x}Ti_x)_{2-y}N_y$ and exhibited a single face-centered cubic (fcc) W_2N structure, while further increasing in titanium content induced the appearance of other fcc-TiN phase and the films was consisted of $(W_{1-x}Ti_x)_{2-y}N_y$ and $(Ti_{1-x}W_x)_{1-y}N_y$. Both the sub-stoichiometric nitrogen content and solid solution strengthening led to the hardness increase from ~26 GPa at 0 at.% titanium to ~39 GPa at 6.7 at.% titanium, while the fcc-TiN phase dropped the hardness with a further increase in the titanium content. The incorporation of titanium below 12.3 at.% dropped the room temperature wear rate significantly. This could be attributed to the increase of hardness to elastic modulus ratio, elastic recovery and hardness. Tungsten titanium nitride film at 12.3 at.% titanium was chosen to investigate the tribological properties at elevated temperatures, and it exhibited the higher working temperature than the binary W_2N film.

Keywords: Reactive magnetron sputtering, Tungsten titanium nitride films, Mechanical properties, Tribological

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