Effects of nitrogen flow ratio on the mechanical and anticorrosive properties of co-sputtered (TiZrHfTa)N_x films

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In this study, (TiZrHfTa)N_x films were prepared through co-sputtering with four sputter guns. The stoichiometric ratio x of (TiZrHfTa)N_x films was varied by adjusting the reactive gas ratio of f_{N2} (N_2/(N_2 + Ar)) at 0, 0.4, and 0.7. With an f_{N2} of 0, the fabricated metallic $Ti_{0.23}Zr_{0.22}Hf_{0.30}Ta_{0.25}$ film, namely N00, exhibited a valence electron concentration of 4.25, a bcc phase with lattice constants of 0.3395 nm, a hardness of 8.0 GPa, and a Young's modulus of 148 GPa. The introduction of N into the TiZrHfTa crystallites transformed the phase from bcc to fcc. N04 [$(Ti_{0.22}Zr_{0.30}Hf_{0.17}Ta_{0.31})N_{0.83}$] and N07 [$(Ti_{0.33}Zr_{0.34}Hf_{0.13}Ta_{0.20})N_{0.88}$] films were prepared when f_{N2} was set at 0.4 and 0.7, respectively. The N04 and N07 films exhibited a common fcc phase with lattice constants of 0.4490 and 0.4464 nm, respectively. The N04 and N07 films exhibited hardness values of 33.2 and 32.2 GPa and Young's modulus values of 379 and 363 GPa, respectively. The corrosion resistance of (TiZrHfTa)N_x films was investigated using potentiodynamic polarization and electrochemical impedance spectroscopy.