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FLEXIBLE HARD Ti-BASED NITRIDES FILMS WITH ENHANCED RESISTANCE TO CRACKING

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The paper reports on the texture (preferred orientation) and mechanical properties of magnetron sputtered Ti(Ni)N_x and Ti(Al,V)N_x films and their resistance to cracking in bending. The films were reactively sputtered on Si(111) plate and Mo strips in a mixture of Ar+N2 gases using a DC magnetron equipped with a TiAlV alloy target (6 at.% Al, 4 at. % V), or a TiNi alloy target (5 at.% Ni) respectively. The preferred orientation, structure, macrostress, mechanical properties (the hardness H, effective Young's modulus E^*, elastic recovery W_e), of Ti(Ni)N_x and Ti(Al,V)N_x films and theirs resistance to cracking in bending were characterized by (i) the X-ray diffraction (XRD), (ii) Scanning Electron Microscope (SEM), (iii) the bending of Si(111) plate using the Stoney`s formula, (iv) the diamond indentation test and (v) the bending of coated Mo strip around a fixed cylinder of small radius (down to 5 mm), respectively. It was found that: (1) the preferred orientation of sputtered Ti(Ni)N_x and Ti(Al,V)N_x nitride films depends on energy $E_{bi} \approx U_s \times i_s/a_D$ delivered to the film during its growth, here is U_s the substrate bias, is the substrate current density and a_D the deposition rate. The texture continuously changes from (i) TiN(220) →TiN(111) +TiN(200) →TiN(220) for Ti(Ni)N_x films and (ii) TiN(200) →TiN(220) →TiN(111) + TiN(220) for Ti(Al,V)N_x nitride films with increasing E_{bi}. (2) The Ti(Al,V)N_x and Ti(Ni)N_x nitride films with low resistance to cracking are prepared at lower value of $E_{bi} < 1.5$ MJ/cm^3 and exhibit (i) low ratio $H/E^* \leq 0.1$, low elastic recovery $W_e \leq 65\%$, compressive macrostress ($\sigma < 0$ GPa) and (ii) are composed of grains contain TiN(200) and show a columnar structure. (3) Both the Ti(Al,V)N_x and Ti(Ni)N_x nitride films with enhanced resistance to cracking are prepared at higher value of $E_{bi} > 3.7$ MJ/cm^3 and exhibit (i) high ratio $H/E^* > 0.1$, high elastic recovery $W_e > 65\%$, compressive macrostress ($\sigma < 0$ GPa) and (ii) are composed of grains witch do not contain TiN(200) and show a dense (voids free) structure.

Keywords
Multifunctional coatings
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Ion bombardment