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Comparative study of Y-doping and Cr-alloying of AlTiTaN-based quaternary nitride

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AlTiSiN and more recently AlTiTaN coatings were shown to present excellent oxidation and wear resistance at high temperature when presenting a composite microstructure i.e. crystalline nitride nanograins rounded by a very thin nitride amorphous phase [1]. Though, some machining applications still need more oxidation resistance coatings at high temperature to get sufficient tool lifetimes. Addition of reactive elements (such as Y) or Cr within AlTiTaN-based coatings is expected to allow an increase of the coating oxidation resistance through the formation of a more alumina protective layer at high temperature [2].
In this work, Cr-alloyed or Y-doped AlTiTa-N quaternary nitride coatings deposited through reactive magnetron sputtering have been studied in order to understand the effect of the added element on the growth i.e. microstructure of those coatings, and thus, on their mechanical properties. Coatings have been prepared from $Ti_{42}Al_{46}Ta_{12}$ and pure Y or Cr targets with content ranging from 0 up to 2.4 at.% for Y and from 0 up to 5 at.% for Cr. X-ray diffraction have already shown different impact of doping and alloying elements on crystalline structure: Y-doping leads to a texture component balance from {111} to {200} cubic AlTiN phase associated to a grain size collapse, whereas Cr-alloying induces progressive diffraction peak shift that suggests Cr incorporation within AlTiN matrix with progressive grain size decrease. Wear behavior and hardness have been examined respectively through tribology and nanoindentation tests and have been analyzed in the prospect of microstructure (transmission electron microscopy) and oxidation behaviors (in situ hot stage x-ray diffraction) of the coatings.
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