KN0700

Plasma Parameters Influencing Growth of HIPIMS-Deposited Monolithic, Nanolayer And Nanocomposite Films

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Intensive ion bombardment is known to densify the microstructure of transition metal nitride thin films, however some deposition conditions have been inaccessible to conventional technologies so far. For example, magnetron sputtering is limited in generating gas ions and metal neutrals, whereas filtered arc techniques generate metal and gas ions with high energy.
High power impulse magnetron sputtering (HIPIMS) is a new technology for deposition of thin films which generates gas and metal ions with low energy, metal ionisation between 5-50% for Ti as measured by atomic absorption spectroscopy and high degrees of gas decomposition between 10-60% for N_2 as obtained from plasma sampling mass spectroscopy. These conditions have been found to influence the structure of single layer, nanolayer and nanocomposite films.
The increased plasma ionisation smoothens the growth front of films and reduces the waviness in nanoscale multilayers such as CrAlYN/CrN and CrAlN/AlSiN.
Fully dense, high purity intercolumnar boundaries can be produced in TiN single layer coatings by HIPIMS deposition at high peak discharge currents in near-production conditions as shown by high-resolution transmission electron microscopy (HRTEM) investigation of cross-sectional and in plane specimens. A build-up of strain energy in the overall material is observed which enhances its hardness. The texture of the films is strongly influenced by the degree of dissociation of nitrogen.
A similar effect is observed in Cr-Al-Si-N nanocomposite structures comprised of nanocrystalline material embedded in a SiN phase. The intensive plasma ionisation and bombardment densify the structure of the overall material and engineer the interface between nanocrystals to promote closer packing observed by HRTEM. This results in reduced misorientation of nanocrystals and increased size of nanoclusters in which they are grouped. The mechanism is crucial in enhancing the film hardness.

Keywords
High power impulse magnetron sputtering (HIPIMS)
nanoscale multilayer films
nanocomposite films
microstructure
plasma diagnostics