PO1022

Structure-stress relationships in nanocrystalline multi-layered AlCrN coatings studied by cross-sectional X-ray nanodiffraction

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Properties of nanocrystalline thin films have been shown to be highly dependent on their microstructure (in terms of texture, size and shape of grains) and stress state. Even in single layered films, gradients of microstructure associated with an inherent variation of surface atomistic processes during subsequent growth stages result in avariation of stresses and film properties across the film thickness. A detailed knowledge of the structure-stress-property relations can be successfully employed in designing films with acomplex architecture and extraordinary properties, e.g. mechanical properties and thermal stability. We will demonstrate in this work how structural variations in multi-layered arc evaporated AlCrN films affect the development of stresses across their thickness. We predominantly focus on the effect of energy of the film forming particle flux on crystallographic structure, microstructure and subsequently on residual stresses of multi-layered AlCrN films with various thicknesses of individual layers. The characterization of depth-evolutions of phases, texture, grain size and residual stresses of the films across their thicknesses relied on cross-sectional position-resolved synchrotron X-ray nanodiffraction experiments performed in transmission geometry with sub-50 nm beam size. The effect of the variation of deposition conditions and combination of constituents of various phase composition within the multilayer structure will be discussed in detail. The results document that pronounced gradients of residual stresses develop within individual layers and across interfaces. This allows to establish structure-stress relationships for multi-layered films with various architecture.

Keywords
Structure-stress
multi-layered
AlCrN
cross-sectional X-ray nanodiffraction
nanocrystalline