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# Competition between local lattice strains and distribution of metallic species in $\text{Ti}_{1-x}\text{Al}_x\text{N}$ coatings with fluctuating $[\text{Ti}]/[\text{Al}]$ ratio

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## Abstract

The effect of a locally fluctuating  $[\text{Ti}]/[\text{Al}]$  ratio in the  $\text{Ti}_{1-x}\text{Al}_x\text{N}$  coatings on the formation of the lattice strains at the  $(\text{Ti},\text{Al})\text{N}/(\text{Al},\text{Ti})\text{N}$  interfaces and the influence of these interfaces on the stabilization of metastable  $(\text{Al},\text{Ti})\text{N}$  with face centered cubic structure were investigated using glancing angle X-ray diffraction, transmission electron microscopy and X-ray spectroscopy. A series of  $\text{Ti}_{1-x}\text{Al}_x\text{N}$  coatings with different  $[\text{Ti}]/[\text{Al}]$  ratios was deposited using cathodic arc evaporation from a titanium and an aluminum cathode. The overall chemical composition was controlled by the position of the respective sample in the deposition chamber and ranged from  $x = [\text{Al}]/([\text{Ti}] + [\text{Al}]) = 0.06$  to  $0.64$ . The local fluctuations of the  $[\text{Ti}]/[\text{Al}]$  ratio were produced by interrupting the deposition from the titanium cathode. It was shown that such local fluctuations of the  $[\text{Ti}]/[\text{Al}]$  ratio generate large contrary residual stresses at the respective side of the  $(\text{Ti},\text{Al})\text{N}/(\text{Al},\text{Ti})\text{N}$  interface. These stresses were almost completely relieved after annealing at  $750^\circ\text{C}$ . The stress relaxation after annealing was accompanied by an equalization of the  $[\text{Ti}]/[\text{Al}]$  ratio and by a decay of the composition fluctuations in the  $\text{Ti}_{1-x}\text{Al}_x\text{N}$  coatings. The stress relaxation and the reduction of the local composition gradients were concluded from measured residual stresses, stress-free lattice parameters and local concentration profiles.

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