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An equivalent homogenized finite element model of TiAl/TiAlN multilayered coatings

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Improving the properties of nanocrystalline metal nitride coatings remains a challenge in metalworking industries, to lengthen tool life and increase cutting performance. One solution consists in depositing metal/nitride multilayered coatings to take advantage of the properties of the nitride, the metal and the interfaces to improve the fracture toughness while maintaining very high hardness. Reactive Gas Pulsing Process (RGPP) is a sputtering technique which allows to easily modulate the stacking of a coating at the nanometer scale. $\text{Ti}_{0.67}\text{Al}_{0.33}$ and $\text{Ti}_{0.54}\text{Al}_{0.46}\text{N}$ (labelled TiAl and TiAlN) monolithic coatings were deposited by radio-frequency magnetron sputtering from a single titanium/aluminium target. $(\text{TiAl}/\text{TiAl})_n$ multilayered coatings, close to 2 μm -thickness, were deposited by RGPP with several n stacking. Identification of the material's elastoplastic behaviour of TiAl and TiAlN was performed using experimental indentation of monolithic coatings for the elastic part. The plastic behaviour was determined using Finite Element Model Updating (FEMU) method from dual indentation technique. A finite element model of $(\text{TiAl}/\text{TiAl})_n$ nano-multilayered coatings reproducing the mechanical behaviour during nanoindentation tests was developed using an equivalent monolithic coating with an elastoplastic behaviour considered as a mixture law of both TiAl and TiAlN monolithic properties. So only one parameter, the equivalent volume fraction V_f of TiAlN, is necessary to define a n multilayered coating and to reproduce both the experimental $P(h)$ curves and the hardness. The obtained V_f for each nano-multilayered coatings are compared with the experimental data obtained by Electron Energy-Loss Spectroscopy at the N-K-edge.