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A novel approach for the prediction of deformation and fracture in hard coatings: comparison of numerical modeling and nanoindentation tests

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Abstract

The mechanical behavior of coating systems is studied by means of a novel numerical modeling approach. The damage and fracture evolution within the coating system are modeled employing cohesive zone (CZ) regions in addition to an elasto-plastic model. The focus of this paper is on hard coatings such as (Cr,Al)N deposited by the combination of the direct current magnetron sputtering (dcMS) and the high power pulsed magnetron sputtering (HPPMS) method. The elasto-plastic properties of the coating are identified indirectly by a nanoindentation test. The morphology of the coating layer is visualized by a scanning electron microscope (SEM). Further the deformation profile after nanoindentation is measured using confocal laser scanning microscopy (CLSM). The numerical results on the measured surface profile and the required force in the nanoindentation test are compared. The coating fracture behavior is investigated by studying the influence of different parameters such as elasto-plastic properties of the coating system and the cohesive zone parameters.

Keywords: Damage, fracture, coating, cohesive zone element, nanoindentation, dcMS, HPPMS