INFLUENCE OF RESIDUAL STRESSES ON COATING FRACTURE BEHAVIOUR IN A SCRATCH TEST

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The contact condition with a sphere sliding over a plate coated with a very thin coating is analysed. The dominant parameters for friction and wear performance are identified and the appropriate material parameters needed for controlling the tribological contact is proposed. A 3D Finite Element Model has been developed for calculating the first principal stress distribution in the scratch tester contact of a diamond spherical tip moving with increased load on a titanium nitride (TiN) coated steel surface. The model is comprehensive in that sense that it considers elastic, plastic and fracture behaviour of the contacting surfaces. Three main regions of stress concentration during the scratching action are identified. The loading mechanisms and the stress development in each of these regions are described.

The first cracks to occur in a TiN coated steel plate sliding against a spherical diamond tip are due to the high stresses in the side-stress region and they are in an angular direction to the formed contact groove at the side edge of the groove. This corresponds to empirical observations. By identifying from a scratch experiment the location of the first crack and using this as input data can the fracture toughness of the coating be determined. In hard coatings there is typically a residual compressive stress field in the coating that is due to changes taken place in the deposition process. These are often in the range of 0,5-2 GPa. The influence of these residual stresses has been studied by using the stress model and the process of their relaxation during the sliding contact is shown. The conclusion is that their influence on the determination of fracture toughness of the coating is not of importance due to the relaxation taking place.