Mechanical Response of Coated Surfaces under Severe Contact Loading

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Abstract

A number of new wear resistant hard coatings for tribological contact are currently being developed to protect interacting surfaces of automobile engine components. However, coating deterioration is one of the main ways in which these components reduce their service lives. To make these coatings not only to protect the surfaces but also to increase their durability, it is necessary to demonstrate their viability by investigating and understanding their mechanical behaviour and potential failure mechanisms. The present work investigates the mechanical response of steel engineered surfaces coated with hard layers with different properties at maximum Hertz contact pressures ranging from 540 MPa to 1540 MPa. The study focused on developing finite element models (using SLODWORK) to study the magnitude and distribution of the contact stresses both with and without surface traction forces due to friction. Stresses arising from differential strain of the impurities that deliberately inserted within the protective coating and the effect of their elastic moduli were also investigated. The results showed how the magnitude and location of the maximum stresses varied as a function of the layer thickness, properties and the loading conditions. The main failure modes anticipated included delamination within the coating, and interfacial delamination. It was concluded that the mechanical behaviour and response of engineered surfaces (with a protective hard coating) depended not only on the coating properties and specifications, but also on the properties and specifications of the whole contact system (substrate, coating, and interface) which is a function of different variables such as contact stresses, coating properties and coating thicknesses, and existence or otherwise of impurities.