Rheological Modeling of NanoIndentation and Verification of the Fracture mechanics of Multi-layered nanostructured coatings

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EXTENDED ABSTRACT

The principal goal of the paper is to reveal whither principal Newton's fundamentals give reliable explanations at examining fracture mechanics of nanostructured coatings and composites or they should be corrected with new theories. The core of principal Newton's fundamentals is based on rheological modeling of strain-deformations of nanostructured coatings.

Alumina-based or diamonds-containing composites were studied. The use of indentation at micro and nanoscales with rheological models as a method for determining the fracture of multi-layered brittle coatings is described. Advantage of the method revealed here is that the only quantity to be measured is a deformation or a fracture load. Use of a refined stress intensity factor formulation for surface-breaking cracks in steep stress gradients has enabled accurate estimates to be made of the minimum loads necessary to propagate cracks by indentation. By measuring this minimum load (and that is the only quantity that must be measured) an accurate estimate of fracture may easily be made with application of rheological modeling.

Rheological behavior of the model under localized loading and different initial stress and deformation states was studied. Analysis of the models and experimental results revealed better understanding of nanocoatings failure and degradation mechanics. Nanocoatings exhibit linear relation of stress curve, whereas unloaded composite shows retardation of deformations (elastic return). The relations of experimental data and calculated data revealed very close agreement of developed rheological model and mechanical behaviour of coatings.

Finally, discussion concerned about a scale at which rheological modeling may be effectively applied to examine the fracture mechanics of nanostructured coatings and composites.