

NEW METHOD FOR THE MICRO- AND NANO HARDNESS MEASUREMENT OF THIN FILM OF MONOLAYER SOLID BY THE INDENTATION OF A SHARP NEEDLE OF A CONE TIP

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UDC 539.4

This study is a mathematical and geometric proof of the expression of the micro- and nanohardness of thin coating resulting from the indentation of a needle form of a cone tip. It is geometric and mathematical modeling of the indentation of the monolayer solid material, where approaches to the coefficients of the model of surfaces mixture are presented. Firstly, formulations of hardness indentations of the composite and the substrate of the mono-layer-coated material have been established. Then, the hardness formula of the thin film of the coating material was derived from the additive law of mixtures. The project imprint result from the indentation of the cone tip on a plane surface is considered as a disk form and the coefficients α and β are ratios of circle surfaces. The hardness of the composite and the substrate of the coating material are expressed as functions of the imprint projected dimensions and the applied load. The contribution of the film to the composite hardness is determined by the model of the surfaces – low mixture of the area – low mixture model. Finally, the expression of the hardness film becomes a function of the composite hardness, the indenter dimension, the imprint dimension, and the film thickness.

Keywords: nanohardness, indentation testing, modeling, cone contact, coating material, measurement.

Nomenclature

H	– height of the cone form
R	– half of diameter of the sharp cone indenter
F	– load applied to the indenter
S	– the projected surface of the print
α, β	– coefficients of the area low mixture model
r	– diameter of the composite projected surface (measured by experiments)
r^*	– diameter of the projected surface of the substrate
e	– film thickness
h	– depth of the imprint
H_{con}	– hardness of the massif materiel of the cone indenter
H_c	– composite hardness
H_f	– hardness of the film
H_s	– hardness of the substrate
S_c	– surface of the composite imprint project

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