

Fundamental Relations for Frictional and Adhesive Nanoindentation Tests

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We discuss the connections between Hertz type contact problems and depth-sensing nanoindentation, when the displacement of the indenter is continuously monitored. For both loading and unloading branches, fundamental relations are derived for indenters of various shapes and for various boundary conditions within the contact region. For the loading branch, relations are derived among depth of indentation, size of the contact region, load, hardness, and contact area, using authors' re-scaling formulae. Further, a relation is derived for the slope of the unloading branch of the adhesive (no-slip) indentation. The relation is analogous to the frictionless BASH relation, that is commonly used for evaluation of elastic modulus of materials, and is independent of the geometry of the indenter. Finally, exact formulae are obtained for adhesive contact between axisymmetric monomial indenters and isotropic, linear elastic materials. These formulae coincide with the frictionless Galin solutions when the material is incompressible.

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