Nanoindentation for Materials Testing

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Nanoindentation is one of a growing number of methods for characterizing the mechanical behavior and properties of materials at the micron and sub-micron levels. In nanoindentation methods, properties are derived from analyses of indentation load-displacement data, most of which are based on continuum descriptions of elastic contact. Elastic contact solutions work curiously well in many circumstances, even when the contact is dominated by plasticity, but in some instances, they are clearly deficient. Experimental results combined with finite element simulations of elastic-plastic contact are presented which show when and why the elastic contact solutions fail to provide accurate results. Other experimental observations are used to illustrate how the principles of continuum plasticity can be inadequate, for example, through the discrete nucleation of dislocations in the vicinity of the contact. The observations emphasize the need for new and better models of elastic-plastic contact at small scales. Time allowing, other important methods for small-scale mechanical testing will also be briefly discussed.

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