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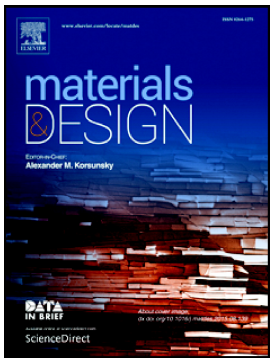

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Estimating Mechanical Properties from Spherical Indentation Using Bayesian Approaches

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Abstract

Instrumented indentation enables rapid characterization of mechanical behavior in small material volumes. The heterogeneous deformation fields beneath the indenter however make it difficult to infer the intrinsic constitutive properties (e.g., Young's modulus, yield strength). This inverse problem is addressed in the literature using optimization techniques that are generally unable to yield robust values for the properties of interest and cannot quantify property uncertainty. Furthermore, current approaches tend to exhibit very high sensitivity to the error definitions and the optimization techniques employed. In order to overcome these difficulties, we propose an alternate approach that involves two main steps: (i) Development of a Gaussian Process (or kriging) surrogate model using finite element models of spherical indentation, and (ii) inverse solution using a Bayesian framework and Markov Chain Monte Carlo sampling. These approaches are demonstrated using selected case studies.

Keywords: constitutive properties, instrumented indentation, Gaussian Process modeling, kriging, finite element surrogate modeling