Thermal contact conductance characterization via computational contact homogenization: A finite deformation theory framework

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Abstract

In order to predict the macroscopic thermal response of contact interfaces between rough surface topographies, a computational contact homogenization technique is developed at the finite deformation regime. The overall homogenization framework transfers macroscopic contact variables such as surfacial stretch, pressure and heat flux as boundary conditions on a test sample within a micromechanical interface testing procedure. An analysis of the thermal dissipation within the test sample reveals a thermodynamically consistent identification for the macroscopic thermal contact conductance parameter that enables the solution of a homogenized thermomechanical contact boundary value problem based on standard computational approaches. The homogenized contact response effectively predicts a temperature jump across the macroscale contact interface. The strong dependence of this homogenized response on macroscale solution variables of interest is demonstrated via representative three-dimensional numerical investigations. The proposed contact homogenization framework is suitable for the analysis of similar energy transport phenomena across heterogeneous contact interfaces where the investigation of the sources for energy dissipation is of concern.