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Full-field identification of inelastic heat conversion during plastic deformation of metals

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Abstract

Reliable thermo-elasto-plastic material modeling demands concurrent mechanical and thermal measurements, yet many identification efforts rely on point-wise measurements, limiting the capture of spatial heterogeneity. This work addresses the increasing interest and development in full-field techniques by exploiting in-situ infrared thermography to separate dissipative and energetic contributions during monotonic, quasi-static tensile loading of oxygen-free copper. A thermodynamically consistent framework is employed, wherein the flow stress is decomposed into energetic and dissipative parts and a sound expression of the heat conversion rate, the so called Taylor-Quinney factor, can be derived [1]. In-situ thermography images are processed allowing for full-field inverse heat source reconstruction [2] combined with phenomenological plasticity model fitting. The employed theoretical framework provides a dislocation based approach to understanding energy and stress partitioning during plastic deformation of metallic materials. By focusing on the full-field identification of the Taylor-Quinney factor, this work contributes to the fundamental understanding of the heterogeneous, discrete and dissipative nature of plastic deformation and lays the fundamentals for further exploration of the interplay between thermomechanical and microstructural effects. Selected experimental results based on in-situ infrared thermography measurements [3] and various identification techniques are discussed. Limitations and prospect for further methodological development are highlighted in the presentation.

Keywords:

full-field identification material modeling Taylor-Quinney factor stress partitioning plastic deformation

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