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Calibrating High Strain Rate Crystal Plasticity Models with Quasistatic Experiments

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Abstract

Parameterisation of crystal plasticity models—including artificial intelligence approaches—commonly relies on fitting model parameters to macroscopic stress–strain responses. This approach suffers from two key limitations: First, multiple parameter sets can reproduce the same experimental data with differences that are comparable to the experimental uncertainty, leading to non-unique constrained solutions. Second, it requires extensive experimental campaigns, which are particularly time-consuming and costly when characterising materials at high strain rates. In this talk, we examine the sources of uncertainty in crystal plasticity modelling and present a framework for parameterising high-entropy alloy models at strain rates up to 103 s^{-1} using only quasistatic tensile experiments across temperatures. We discuss the contributions of experimental and modelling uncertainties, and we mitigate them by incorporating mesoscale experimental data obtained from material proxies. Finally, we highlight open challenges and emerging opportunities for improving the predictive capability of crystal plasticity models across multiple loading conditions.

Keywords:

Crystal Plasticity parameterization mesoscale modelling high strain rate