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Towards mechanism-based simulation of impact damage using Exascale computing[1] ANTON SHTERENLIKHT, University of Bristol, LEE MARGETTS, SAMUEL MCDONALD, NEIL BOURNE, University of Manchester
— Over the past 60 years, the finite element method has been very successful in modelling deformation in engineering structures. However the method requires the definition of constitutive models that represent the response of the material to applied loads. There are two issues. Firstly, the models are often difficult to define. Secondly, there is often no physical connection between the models and the mechanisms that accommodate deformation. In this paper, we present a potentially disruptive two-level strategy which couples the finite element method in the macroscale with cellular automata in the mesoscale. The cellular automata are used to simulate mechanisms, such as crack propagation. The stress-strain relationship emerges as a continuum mechanics scale interpretation of changes at the micro- and meso-scales. Iterative two-way updating between the cellular automata and finite elements drives the simulation forward as the material undergoes progressive damage at high strain rates. The strategy is particularly attractive on large-scale computing platforms as both methods scale well on tens of thousands of CPUs.

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