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Data driven multiscale modeling of architected materials

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Kirchdoerfer and Ortiz [2] proposed a new approach which avoids the need of constitutive model in computational mechanics, replacing it by material data. In this model free approach, the compatibility and equilibrium equations are kept the same as in classical approach, while the material model is replaced by the material database made of a number of stress-strain pairs. Material data can be collected either through experimental measurements ([1]) or numerical simulation.
The later is related to recently proposed multiscale data-driven (MSDD) method [4] which permits to generate the material data directly from the lower-scale simulations. As in the standard multiscale (FE^2) method, the representative volume element (RVE) with a fine discretization is accurately describing the material microstructure. The advantage of the MSDD method is that the microscale simulation is performed in the offline phase, decoupling this way macro- and microscale. For the (offline) generation of the material database, RVEs are submitted to numerous deformation states enforced with periodic boundary conditions. Using standard computational homogenization enables to constitute the material database containing homogenized macroscopic stresses and strains. In the offline phase tremendous online computations of the classical FE^2 method are replaced by searching points in the database.

We explore in this work a computational approach to generate material database which is further used to simulate the deformation process of the metal lattice-based architected materials [3] produced with Selective Laser Melting device.

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