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Computational Crystal Plasticity based on the Virtual Element Method

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A finite crystal plasticity framework embedded within a virtual element environment is outlined in this work. Micro-structures of metallic materials or ceramics and composites consist of poly-crystals. A consistent model has to take the underlying physics at this scale in account. Hence, a multi-slip crystal plasticity model is employed to properly describe the inelastic response. This is based on a dislocation-movement through the lattice in a homogenized way, introduced in terms of the plastic shear. The aim of this contribution is to compare classical FE-approaches with novel virtual element formulations.
The ability of virtual elements to be of arbitrary shapes with various number of nodes is addressed in the present work. In doing so, a perfect fit to the underlying polycrystalline micro-structures can be achieved. It is shown, that the Virtual Element Method (VEM) provides an accurate framework in geometrically heterogeneous and anisotropic regimes with multiple-slip scenarios. In addition, a study on the homogenization behavior of the presented constitutive model is illustrated. The numerical examples proposed in this contribution stem out from the *DFG collaborative research centre CRC1153/C4*.