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ANALYSIS OF THE BEHAVIOUR OF POLYCRISTALLINE MATERIALS THROUGH MICROMECHANICAL SIMULATIONS

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Computational homogenization methods employing crystal plasticity constitutive models have been developed and used in many applications in recent years. This strategy is well accepted due to the ability to take into account the heterogeneity of the microstructure, thus gaining information about the local deformation at the grain scale [1-3]. These physics-based constitutive equations not only provide better predictions of the anisotropic material response but can also capture the texture evolution in a polycrystalline sample subjected to finite plastic deformation. When considering the numerical approach for evaluation of the effective properties, the use of the Representative Volume Element (RVE) can lead to very large computational cost. Therefore, it is necessary to determine the appropriate size of the RVE of polycrystalline materials to be computed in order to get a precise enough estimation of effective properties.

In this contribution, a general micromechanical framework was developed for modeling polycrystalline materials. The Voronoi diagram was used to generate the virtual geometry of the RVE with random grain shapes, and an initial distribution of crystallographic orientations to represent the polycrystalline morphology. Each material grain was modelled by a crystal plasticity constitutive model. The size of the RVE composed by cubic polycrystals was investigated with periodic boundary conditions under different texture distributions. A relationship between the RVE size and the macro homogenized stress-strain response was studied.