Nested Marked Tessellations Applied to the Modelling and Simulation of Deformation Twinning in Polycrystalline Materials

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Abstract

A new variant of a model in stochastic geometry, random nested marked tessellation, is developed and investigated for applications in the study of polycrystalline materials. Conditionally on a 3D Laguerre tessellation in a bounded window, a parametric stochastic model of crystallographic texture is chosen, represented by a mark probability distribution of a cubic lattice orientation of a cell. Both an independent and dependent marking is considered. Subsequently, given a loading direction of a specimen, the theory of Schmid factor and deformation twinning yields a rule, based on the propensity for twinning, for the appearance of twin lamellae in a cell, with specific normal direction. Their total volume fraction within a cell is assumed to be proportional to macroscopic deformation. We suggest a probabilistic model for the number, location and width of the lamellae. Their crystallographic orientation is determined by the reorientation of the mother cell. Lamellae and interlamellar spaces form subcells. The resulting nested tessellation is not normal. We simulate its realizations to explore the dependence of basic characteristics of the model on the parameters, primarily on texture and macroscopic deformation.

References

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