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Thermodynamics of polycrystalline materials within the theory of mixtures with continuous diversity

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The physics of polycrystalline materials is described via microscopic processes such as grain boundary migration, grain growth, grain rotation, polygonization (the bending and breaking of crystallites) and evolution of dislocation density. The importance to take these processes into account lies in their in uence on the mechanical behaviour of the material. Constitutive equations to describe such phenomena have been proposed in the literature. The main result of this paper is to give a general and thermodynamically consistent approach for such constitutive equations. The framework of the Theory of Mixtures with Continuous Diversity (TMCD) is used. The inclusion of both orientation and grain-size distributions is presented in this paper for the rst time. Their introduction requires the formulation of a new and general constitutive theory that is, therefore, given. The method of Lagrange multipliers used in the context of the entropy principle provides the restrictions of the second law of thermodynamics on the constitutive equations. The success of this work is that all the main results present in the literature can be incorporated in this framework.