The micromorphic approach to cracking in single crystals and phase field modeling of oxidation

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Gradient theories are now classically used for the simulation of plasticity and damage in engineering materials. An anisotropic gradient damage model will be presented to simulate the crack initiation and propagation in metal single crystals. It relies on the coupling of crystal plasticity with micromorphic damage variables [1]. Application deal with the fatigue behavior of single crystal nickel-based superalloys [2].
Phase field models often used for the simulation of the morphology of phases during phase transformation are also gradient theories. They can be implemented in finite element codes in the same way as the previous micromorphic model class. Phase transformation is coupled with crystal plasticity in the considered example of oxidation at the free surface and along the grain boundaries of a metal polycrystal [3]. Homogenization methods are used to simulate the elastoviscoplastic behavior inside the diffuse boundaries [4].

[1] O. Aslan, N.M. Cordero, A. Gaubert, S. Forest, *Micromorphic approach to single crystal plasticity and damage* , International Journal of Engineering Science, vol. 49, pp. 1311-1325, 2011. doi:10.1016/j.ijengsci.2011.03.008

[2] O. Aslan, N.M. Cordero, A. Gaubert, S. Forest, *Micromorphic approach to single crystal plasticity and damage* , International Journal of Engineering Science, vol. 49, pp. 1311-1325, 2011. doi:10.1016/j.ijengsci.2011.03.008

[3] K. Ammar, B. Appolaire, S. Forest, M. Cottura, Y. Le Bouar and A. Finel, *Modelling inheritance of plastic deformation during migration of phase boundaries using a phase field method*, Meccanica, vol. 49, pp. 2699-2717, 2014. doi:10.1007/s11012-014-0011-1

[4] V. de Rancourt, B. Appolaire, S. Forest and K. Ammar, *Homogenization of viscoplastic constitutive laws within a phase field approach* Journal of the Mechanics and Physics of Solids, vol. 88, pp. 291-319, 2016. doi:10.1016/j.jmps.2015.12.026