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POLYCRYSTALLINE MODELING OF THE PORTEVIN-LE CHATELIER EFFECT

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The Lüders band and Portevin - Le Chatelier (PLC) effects have been observed for many metallic materials on their tensile stress strain curve at least in a given range of temperature and prescribed strain rate. These both effects have been modeled using a suitable set of constitutive equations [1, 2] and finite element model of homogeneous 2D and 3D specimens [3, 4]. The material model called KEMC is based on an additional internal variable: the aging time denoted t_a. This latter induces a stress over-hardening corresponding to the pinning of dislocations due to strain aging phenomenon (diffusion of solute atoms). This over-hardening leads to a negative strain rate sensitivity of the model at least in a given range of strain rate and induces serrations on the tensile curve and localisation of the deformation.

This effect has also been recently observed under cyclic loading conditions [5] on Cobalt alloys; or for low strain rates (1.e-6 s^{-1}) in a commercially pure Titanium alloy at room temperature. In this last case the PLC effect has been observed in a range of global strain rate for which strain rate sensitivity is positive. The original isotropic formulation of the KEMC model is not able to simulate such a phenomena and simulations at a lower scale are requested.

The over-hardening term of the original KEMC model has been introduced in a crystal plasticity model in order to simulate the band propagation associated with the PLC and Lüders effects in single-crystal and poly-crystalline aggregates. The model has been tested on BCC and HCP materials, for different number of grains with random or textured orientations.

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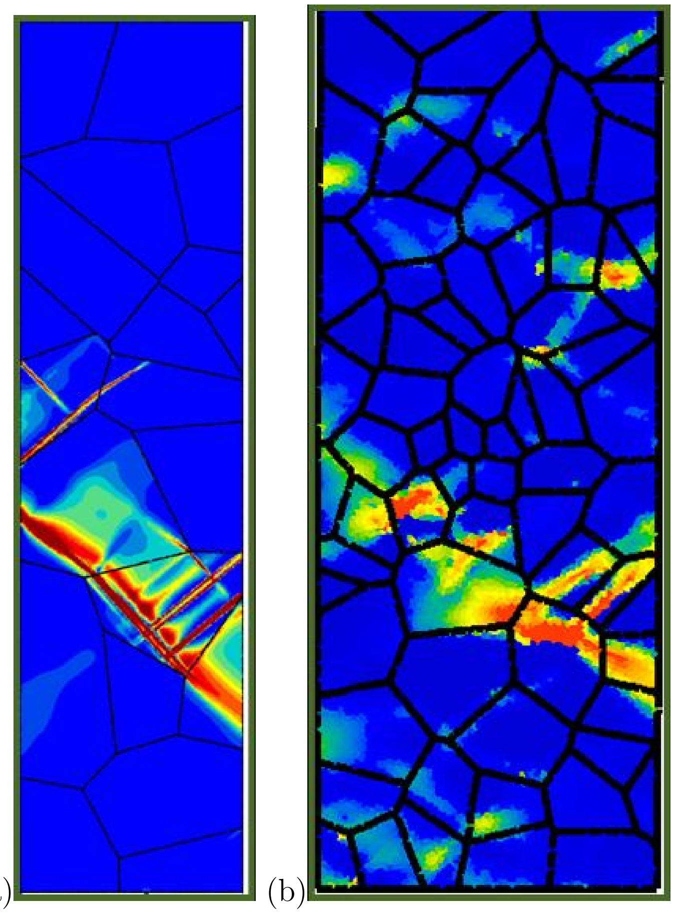

(a) (b)

Figure 1: Simulation of (a) Lüders band propagation in Tantalum aggregate (D.Colas), (b) Portevin - Le Chatelier band propagation Titanium (A.Marchenko) aggregate

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