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Combined effect of grain size contrast and grain spatial distribution on the elastoplasticity of bimodal polycrystals

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Grain size (GS) reduction in metal alloys is known to result in an increase of the yield stress and ultimate strength but meanwhile the ductility can be significantly affected which can be detrimental for forming processes. In this study it is proposed to circumvent this effect by introducing coarse grains (CG) in a matrix of ultrafine grains (UFG).

Experimental analyses are performed on bimodal tensile test specimens elaborated by powder metallurgy and Spark Plasma Sintering. This technique enables a precise control of CG and UFG sizes and mass fractions [1]. Finite element modelling of polycrystals with explicitely described grain-scale microstructure is jointly developed in order to analyse the microstructure-properties relationships from the micro- to the macro-scale.

Polycrystalline microstructures are generated by means of Laguerre-Voronoi tessellations with a control on GS, spatial distribution and morphology [2]. Constitutive models with different levels of accuracy wrt physics are compared: *(i)* a simple biphase configuration where each grain population's behavior is described with a macrohomogeneous law, full-field crystal plasticity with *(ii)* phenomenological laws including a Hall-Petch term in the definition of the resolved shear stress or with *(iii)* a dislocation-density based model (Tabourot) including a GS dependent term. The relevance of each approach is thus analysed at different scales for different GS contrasts and spatial distributions of CG.

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