
Continuous modeling of dislocation in concentrated random alloys

Pierre-Antoine Geslin^{*1}, Vincent Démery, Alberto Rosso², and David Rodney[†]

¹Matériaux, ingénierie et science [Villeurbanne] – Université Claude Bernard Lyon 1, Institut National des Sciences Appliquées de Lyon, Centre National de la Recherche Scientifique, Centre National de la Recherche Scientifique : UMR5510 – France

²LPTMS, CNRS, Univ. Paris-Sud – Centre National de la Recherche Scientifique - CNRS – France

Abstract

The study of dislocation-solute interactions is central in metallurgical sciences because of the significant influence of solutes on the mechanical response of alloys. In particular, solid solution strengthening is taken advantage of in the recent development of high entropy alloys.

To investigate solid solution strengthening in concentrated alloys, our work is articulated around two steps. We first develop an elastic model of random alloys where atoms of different sizes are modeled as Eshelby inclusions embedded in an isotropic elastic medium. This allows to derive analytical expressions for the variance of the elastic fields (displacements, strains, stresses) as well as their spatial correlations. We show that stress correlations are highly anisotropic despite the use

of isotropic elasticity and the randomness of the alloy (1,2).

The second step consists in using this correlated stress environment in a dislocation dynamics framework to derive the critical stress related to the dislocation depinning (3,4) as well as the dislocation roughness at the depinning threshold. Adding a Langevin noise also enables following the dynamic of the dislocation with temperature and to investigate how the applied stress influences the energy barrier distribution. These numerical results enable to critically assess the validity and the limitations of average models from the literature (5). (1) P.-A. Geslin and D. Rodney. *J. Mech. Phys. Sol.* 153, 2021, 104479.

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*Corresponding author: pierre-antoine.geslin@insa-lyon.fr

†Speaker