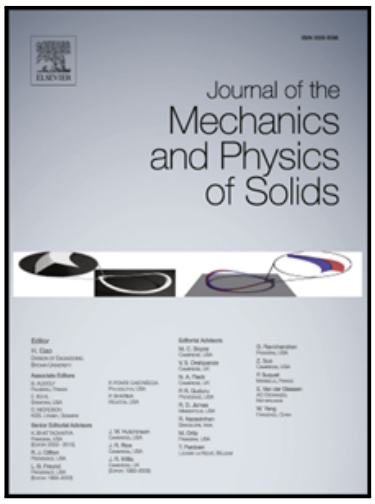

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A statistical theory of probability-dependent precipitation strengthening in metals and alloys

Qihong Fang[a], Li Li[a], Jia Li[a*], Hongyu Wu[b], Zaiwang Huang[b], Bin Liu[b], Yong Liu[b], Peter K Liaw[c]

[a] *State Key Laboratory of Advanced Design and Manufacturing for Vehicle Body, Hunan University, Changsha, 410082, PR China*

[b] *State Key Laboratory of Powder Metallurgy, Central South University, Changsha, 410083, PR China*

[c] *Department of Materials Science and Engineering, The University of Tennessee, Knoxville, TN 37996, USA*

* Corresponding author. E-mail address: lijia123@hnu.edu.cn (J. Li).

Abstract

The classical precipitation-strengthening models, described by either the Orowan mechanism or the cutting mechanism, rely on a single average size and dispersion of the precipitates obtained by the experimental observations. However, the continuous unimodal or multimodal size-distribution precipitates are formed in the alloy matrix, and always interact with dislocations via not only the looping mechanism but also the cutting mechanism although the precipitation size is larger than the critical size for determining the looping or cutting mechanism. Here, we propose a new precipitation-strengthening theory, which is a probability-dependent precipitation-strengthening mechanism, to more accurately predict the strengthening contribution of precipitates. The yielding strength obtained from the probability-dependent precipitation-strengthening model is in good agreement with the result of experiments, which is more accurately estimated, compared to the prediction of the classical precipitation-strengthening model, in particular, for the large precipitation size. In addition, the difference of the tensile strength from the classical model and our model comes