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Binary dislocation junction formation and strength in hexagonal close-packed crystals

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Abstract

This work examines binary dislocation interactions, junction formation and junction strengths in hexagonal close-packed (*hcp*) crystals. Through a line-tension model and dislocation dynamics (DD) simulations, the interaction and dissociation of different sets of binary junctions are investigated involving one dislocation on the $(01\bar{1}0)$ prismatic plane and a second dislocation on one of the following planes: (0001) basal, $(1\bar{1}00)$ prismatic, $(1\bar{1}01)$ primary pyramidal, or $(\bar{2}112)$ secondary pyramidal. Varying pairs of Burgers vectors are chosen from among the common types: the basal type $\langle a \rangle$: $\frac{1}{3}\langle 11\bar{2}0\rangle$, prismatic type $\langle c \rangle$: $\langle 0001\rangle$, and pyramidal type $\langle a+c \rangle$: $\frac{1}{3}\langle 11\bar{2}\bar{3}\rangle$. For binary interaction due to dislocation intersection, both the analytical results and DD-simulations indicate a relationship between symmetry of interaction maps and the relative magnitude of the Burgers vectors that constitute the junction. Using analytical formulae, a simple regressive model is also developed to represent the junction yield surface. The equation is treated as a degenerated super elliptical equation to quantify the aspect ratio and tilting angle. The results provide analytical insights on binary dislocation interactions that may occur in general *hcp* metals.

Keywords

A. Dislocations, A. Dynamics, B. Elastic material, C. Analytic functions