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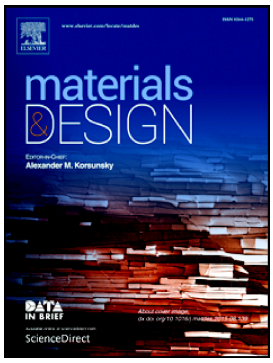

Effects of crystal orientations on the cyclic deformation behavior in the low cycle fatigue of a single crystal nickel-base superalloy

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Effects of crystal orientations on the cyclic deformation behavior in the low cycle fatigue of a single crystal nickel-base superalloy

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Abstract: Cyclic stress responses during low cycle fatigue of a Re-bearing Ni-base single crystal superalloy with [001], [011] and [111] orientations have been investigated at 980 ºC, and attention is paid to the corresponding deformation microstructure to establish a clear microstructure-mechanical relationship. It is found that deformation of the [001] specimens with increased strain amplitude is characterized by cyclic softening at the early stage, while the [011] and [111] specimens exhibit cyclic softening under large strain amplitude and cyclic hardening under small cyclic amplitude. The softening response is related chiefly to the formation of dislocation networks, γ′ degradation and the dislocation recovery process. Moreover, plenty of parallel aligned dislocations in the [011] specimens reduce the probability of dislocation interactions among different slip systems, resulting in cyclic hardening. With respect to the [111] specimens, since a considerable number of dislocations pile up in γ channels, the resistance of the dislocation movement increases and cyclic hardening is resulted. Our results throw light upon microscopic deformation mechanism responsible for the cyclic stress response behaviors of the alloy with various orientations.

Keywords: Single crystal superalloy; Low cycle fatigue; Deformation anisotropy; Deformation mechanism

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