Solid Solution Hardening and Point Defects in NiAl Alloys

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It is known that point defects such as vacancies can cause significant hardening in B2 intermetallic alloys at ambient temperatures. However, the interaction of point defects with solute atoms and their resulting hardening effects are not well understood at the present time. In this study, NiAl alloys with on- and off-stoichiometric compositions were prepared, and solute additions of iron were added to the binary alloys in order to control both vacancies and anti-site defects in the alloys. It was surprisingly found that both solid solution hardening and softening were observed in NiAl alloys, depending on alloy stoichiometry. Substantial hardening was observed in stoichiometric NiAl where iron solutes were added to replace Ni atoms. On the other hand, solid solute softening by iron was detected in the Ni-rich alloys. The different hardening behaviors can be fully explained in terms of point-defect concentrations and sublattice occupation of Ni and Fe atoms.

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