Dual-function nanoprecipitates enhance the strength and ductility of a medium-entropy alloy

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We present here a novel use of precipitates to tune transformation-induced plasticity *via* the spatial confinement due to closely spaced nanoprecipitates. When this is combined with conventional precipitation hardening, high strengths can be achieved without a significant trade-off in ductility. This dual functionality is demonstrated in model Fe-Ni-Al-Ti medium-entropy alloys, one of which is a single-phase solid solution whose composition was designed to undergo an FCC to BCC martensitic phase transformation upon quenching from elevated temperatures, while the other was designed as a two-phase alloy containing nanoscale $L1_2$ precipitates in an FCC matrix whose composition is identical to the single-phase alloy. When precipitate size/spacing are carefully controlled, the matrix of the precipitate-containing alloy, instead of transforming, remains as metastable FCC constrained by the surrounding precipitates. Then, during tensile testing, it undergoes a deformation-induced transformation to BCC. This leads to high work hardening, which when combined with a conventional precipitation hardening mechanism (dislocation cutting in our alloy), results in enhanced strength and ductility. Broader implications for the design of high-strength alloys utilizing sequential deformation mechanisms are discussed.

Keywords: Tensile properties, phase transformation, medium-entropy alloy, strength, ductility, work hardening.

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References:

[1] Yang et al., Bifunctional nanoprecipitates strengthen and ductilize a medium-entropy alloy, *Nature*, **595**, 2021, 245-249.