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Predicting the Morphologies of γ' Precipitates in Cobalt-Based Superalloys

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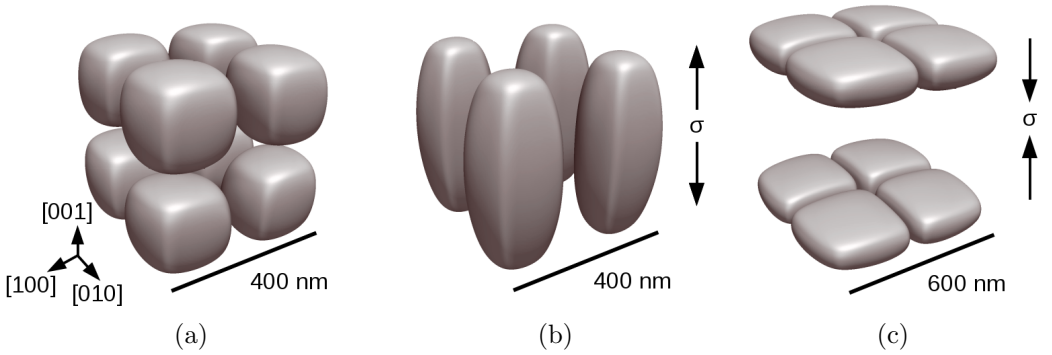

Caption: *Characteristic microstructures develop as a function of the applied stress (stress orientation is indicated by the arrows). a) No applied stress results in cuboidal precipitates, b) 400 MPa applied in tension results in rods aligned parallel to the stress, c) 400 MPa applied in compression results in plates aligned perpendicular to the stress.*

Scientific Achievement

We demonstrated how interfacial and elastic energies, especially as impacted by misfit strain, influence the equilibrium shapes of coarsened and rafted Co-Al-W γ'-precipitates. The meso-scale simulations included interfacial energies and elastic constants obtained from first-principle calculations.

Significance

Our results yielded microstructures with the same morphology as observed in experiments, indicating that the elastic stresses arising from coherent interfaces between the γ'-precipitates and the γ matrix are important for morphological evolution during creep. Our results also showed characteristic microstructural features, such as narrow γ channels between γ'-precipitates, are not merely kinetic artifacts during coarsening but are in fact energetically favored. We also provided an explanation for the experimentally observed directional coarsening that occurs without any applied stress. These results can impact alloy design and coarse-grained microstructure evolution models.

Citation

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