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Enhancing the High-Temperature Strength of a Co-Base Superalloy by Optimizing the y/y' Microstructure

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The newly developed polycrystalline Co-base superalloy CoWAlloy2 provides a high potential for application as wrought alloy due to the large gap between solidus and y' solvus temperature along with a high y' volume fraction. The scope of this study was to maximize the high-temperature strength and to optimize the y/y' microstructure by adjusting the multi-step heat treatments.
The microstructure and mechanical properties were investigated by scanning electron microscopy (SEM), transmission electron microscopy (TEM), compression and hardness tests. In-situ high temperature small angle neutron scattering (SANS) helped to understand the microstructural evolution during different applied heat treatments. The size of the y' precipitates increases with increasing annealing time and temperature of the first annealing step. As a result, the hardness of the alloy increases until a maximum after 4 h annealing is reached. The reason is an optimum y' precipitate size in the range of about 30-40 nm, which can be explained by the model for shearing of the y' precipitates by weakly and strongly coupled dislocations. A second annealing step leads to a further increase of yield strength due to an exceptionally high y' volume fraction of about 70%. The room temperature yield strength of the optimized condition is 140 MPa higher compared to the other heat-treated condition.

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