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Cracking during high temperature deformation of a high-strength polycrystalline Co-base superalloy

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The polycrystalline Co-base superalloy CoWAlloy1 provides a high potential for high temperature applications as wrought alloy due to a high γ' precipitate fraction and γ/γ' lattice misfit which lead to excellent creep properties. However, cracking occurs during hot rolling. Therefore, this study investigated the origins of crack formation during processing.
Compression tests at temperatures between 1000–1150 ℃ and different strain rates were executed to characterize the deformation at high temperatures. The formed cracks were analyzed by scanning electron microscopy (SEM). An intercrystalline crack propagation could be revealed if cracking occurred. The tendency of crack growth decreases with increasing temperature. Apparently, the precipitation of γ' phase and the absent recrystallization lead to pronounced crack propagation below the γ' solvus temperature. In-situ high temperature small-angle neutron scattering (SANS) helped to understand the phase fractions and precipitate size distributions at different processing temperatures. A low γ' volume fraction is present at the heat treatment temperature of 1075 ℃ while a high fraction of γ' precipitates forms during cooling to 750 ℃. In consequence, the material provides a high strength when the hot bar encounters with the cold rolls during hot rolling due to the high amount of γ' phase in the rim of the bar and thus cracking starts there. Instead of that, the strength is decreased and crack growth is minimized at 1075 ℃.

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