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Studying the temperature-dependent lattice misfit of γ' strengthened superalloys with a varying Co/Ni-ratio using neutron and high-resolution X-ray diffraction

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Superalloys strengthened by ordered γ' precipitates are widely used in aircraft engines due to their excellent high-temperature properties and play, therefore, an essential role for mobility. The γ matrix phase and the coherently embedded γ' precipitates have slightly different lattice parameters due to their different chemical compositions resulting in a constrained lattice misfit between both phases. In this study, the lattice misfit of the model alloy series Ni–Co–9Al–8W–8Cr (at.%) with a varying Co/Ni-ratio was investigated by neutron and X-ray diffraction. The room temperature lattice misfit of polycrystalline (PX) samples was investigated by means of neutron diffraction. Moreover, the lattice misfit of single crystalline (SX) samples as a function of the temperature was studied by employing high-resolution X-ray diffraction (HRXRD) up to 1000 °C. The Co/Ni-ratio strongly affects the sign of the lattice misfit and its temperature-dependent behavior. The Ni-rich alloys show a negative lattice misfit at room temperature that becomes more negative at higher temperatures. In contrast, the Co-rich alloys exhibit a positive lattice misfit at room temperature strongly affect the resulting coherency stresses within the alloys and thus mechanical properties, knowledge of the temperature-dependent lattice misfit is crucial for future superalloy development.

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