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Hardening phase precipitation study in the new VDM® Alloy 780 by in-situ high temperature neutron scattering techniques

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In order to improve the microstructure and mechanical properties of newly developed Ni-base superalloy VDM® Alloy 780 it is necessary to understand the γ' hardening phase precipitation process. Here the precipitation process was studied in-situ by time-of-flight (TOF) neutron diffraction (ND) and small-angle neutron scattering (SANS) experiments at high temperature, which allowed us to characterize the obtained γ' precipitates, amount and sizes (by SANS from the very early stages) and the misfit between matrix and precipitates (by ND). Besides, atom probe tomography (APT) and scanning electron microscope (SEM) provided further details on microstructural and chemical composition.

The precipitation of γ' phase at 720 °C and its size and volume fraction changes as a function of time was monitored in two differently solution-annealed samples. It appears that the obtained results depend on the heat treatment history of the sample. Two particle size distributions of γ' precipitates were detected by SANS after 2 h in the case of the sample with an extra step after solution-annealing. Variation in heating rates of SANS and TOF ND measurements results in different precipitates nucleation and growth kinetics. A final heat treatment at 620 °C does not lead to a similar precipitation or growth process.

The in-situ SANS measurements at 750 °C of the fully precipitation hardened sample with two particle size distributions of γ' precipitates at RT confirms the matrix-diffusion-controlled Ostwald ripening of the precipitates.

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