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Coarsening and precipitation kinetics of TaC precipitates in Co-Re alloys

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There is a need to supplement Ni-base superalloys in future gas turbines for gas entry temperatures > 1500 ℃ to improve their efficiency. Co-Re-Cr based alloys are a promising candidate, since they have the required high melting point as well as the required strength. Measurements by means of small-angle neutron scattering (SANS) and neutron diffraction (ND) were an important part of their development in the past several years. These methods allow the investigation of the complex interplay between the different phases that are present in nano- and mesoscopic scale in-situ at high temperatures (up to 1500 ℃). Especially with SANS, it was possible to observe the size distribution of fine Tantalum mono-carbide precipitates (<30 nm) and their evolution within the matrix of a Co-Re-Cr-Ta-C alloy. In addition, ND shows that the Co-Re alloy matrix undergoes an allotropic transformation hcp ↔ fcc at temperatures > 1200 ℃, similar to pure Co (at 400 ℃). This transformation is very sensitive to the Cr and Re content since they stabilize the hcp-Co phase. The fine TaC precipitates can imbed semi-coherently in the hcp-Co matrix and are therefore very sensitive to the Co matrix phase [1].

In this contribution, the influence of Co-Re matrix transformation on the fine TaC precipitate morphology is presented. Alloys with a Ta content of 1.2 at.% and varying C/Ta ratios from 0.5-1 were studied in order to investigate the stability of TaC phase in form of fine precipitates in detail. The coarsening kinetics at high temperature, as well as the formation and dissolution of TaC phase at temperatures > 1200 ℃, was determined. Moreover, the influence of Chromium addition to the alloy matrix is discussed.

References

[1] L. Karge, R. Gilles, D. Mukherji, P. Strunz, P. Beran, M. Hofmann, J. Gavilano, U. Keiderling, O. Dolotko, A. Kriele, A. Neubert, J. Rösler, W. Petry, The influence of C/Ta ratio on TaC precipitates in Co-Re base alloys investigated by small-angle neutron scattering, Acta Materialia (2017).

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