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Dependence of Ta-C precipitate stability and growth on allotropic Co-Re matrix transformation

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There is a need to supplement Ni-base superalloys in future gas turbines with turbine entry temperatures > 1500 °C to improve their efficiency. Co-Re alloys are a promising candidate, since they have high melting point > 1700 °C, 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 [1],[2]. The complex interplay between the different nanoscale and mesoscopic phases could be studied in-situ at high temperatures. Especially with SANS, it was possible to observe the size distribution of fine Tantalum mono-carbide precipitates and their evolution within the matrix of a Co-Re-Ta-C alloy. Similar to pure Co-alloys, the Co-Re matrix undergoes an allotropic transformation hcp ↔ fcc at temperatures > 1100 °C, where the exact temperature depends on composition. Alloys without Cr contain some remnant metastable fcc at room temperature. The amount and size distribution of the TaC phase strongly depends on the C/Ta ratio in the alloy [3]. Addition of Chromium is important to improve oxidation behavior of the alloy system. However, Cr also has an affinity to C and forms carbides. It is also a hcp stabilizer of the Co-Re matrix.
Alloy with Ta content of 1.2 at% with varying C/Ta ratio from 0.5-1 was studied in order to investigate the TaC phase stability. Currently, the influence of different heat treatments on the TaC precipitates are under investigation. In-situ SANS and microscopic studies show that precipitates coarsen but remains small (< 80 nm) at temperatures up to 1300 °C.
In this contribution, the influence of the Co matrix transformation on the fine TaC precipitate morphology is presented. Moreover, the influence of Chromium addition to the alloy is discussed.

References

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Author: KARGE, Lukas

Co-authors: Dr MUKHERJI, Debashis (TU Braunschweig); Dr STRUNZ, Pavel (Nuclear Physics Institute); Dr BERAN, Přemysl (Nuclear Physics Institue); GILLES, Ralph

Presenter: KARGE, Lukas

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