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High-temperature stability of matrix in boron-containing Co-Re-Cr alloys for gas turbine applications

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Co-Re-based alloys [1] are developed to supplement single crystal Ni-based superalloys in future gas turbines. Addition of boron to the Co-Re-based alloys largely increases their ductility [2] and is thus advantageous. On the other hand, the stability of the matrix at the foreseen metal operation temperatures (≥1200℃), which can be influenced by the presence of boron, is also an important concern for the alloy development.

Therefore, the influence of boron addition on Co-Re stability was investigated in situ at high temperatures using neutron diffraction (MLZ Garching). It was found for the Co-17Re-23Cr alloy that the increased boron concentration changes significantly, but not monotonically, the hcp to fcc matrix transformation temperature [3]. The reason is an interplay between amount of boron in the matrix and amount of sigma phase (Cr2Re3) which binds hcp-stabilizing element Re.

Moreover, increasing boron concentration also lowers temperature at which evaporation of Co and/or Cr occurs, followed by an appearance of second or even third hcp matrix phase. The formation of these additional hcp phases was observed at temperatures >1430℃. This effect is not detrimental to the alloy development as the evaporation starts significantly above the foreseen operation temperature.

[1] J. Rösler et al., Adv.Eng.Mater. 9, 2007, 876
[2] D. Mukherji et al., Scr.Mater.66, 2012, 60
[3] P. Strunz et al., Met.Mater.Int., 2018, doi.org/10.1007/s12540-018-0121-8

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