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In situ studies at elevated temperatures on CoRe alloys for ultra-high temperature applications using X-ray/neutron diffraction and small-angle neutron scattering

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Ni-base superalloys, well known as high-temperature alloys, are used in gas turbines (both stationary for electric power generation and in aircraft). They fulfill the requirements of high-temperature strength, ductility, corrosion resistance and high creep resistance needed in these applications and have a stable microstructure. Due to the fact, that the service temperature already reached 80% of the Ni melting point, new alloy systems in industry are under consideration to substitute Ni-base superalloys in future.

In this contribution CoRe based alloys will be presented as a potential candidate for future applications [1]. Why CoRe alloys? Co-based alloys are already in use as gas turbine material in static components like turbine vanes or in combustor sections because of their intrinsic properties and the ease of manufacturing. The melting point of Co alloys can be considerably enhanced with Re additions (Re has the third highest melting point in the periodic table). The binary Co and Re system is isomorphous with an hcp structure at room temperature. Additions of Ta, C, Cr and B lead to further improvements of the properties in the CoRe alloy. The main contributor to the strength of the CoRe alloy are fine TaC precipitates with sizes below 100 nm which are homogenously distributed in the alloy. In-situ experiments at very high temperatures (up to 1500°C) with neutron scattering techniques have been used in this study because of the high penetration ability of neutrons and the large neutron beam cross section (about 1 cm2). Consequently, these kinds of measurements obtain a large volume representative bulk result from the investigated CoRe alloys [2].

[1] J. Rösler, D. Mukherji, T. Baranski (2007), Adv. Eng. Mater 9, 876-881.
[2] R. Gilles, D. Mukherji, L. Karge, P. Strunz, P. Beran, B. Barbier, A. Kriele, M. Hofmann, H. Eckerlebe, J. Rösler, J. Appl. Cryst. (2016), 49, 1253-1265.

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