Contribution ID: **60** Type: **Talk**

How neutron and synchrotron measurements are aiding Co-Re alloy development for gas turbines and supplementing electron microscopy studies

Wednesday 19 September 2018 14:00 (15 minutes)

Co-Re based alloys are being developed at the Technische Universität Braunschweig [1], to complement Ni-superalloys in gas turbine engines. Their main advantages are high melting temperature, very high specific strength, good ductility and good oxidation resistance. The Co-Re alloys are strengthened by a fine dispersion of carbides, particularly MC type TaC but unlike gamma-gamma prime based Ni-superalloys, they have a rather complex microstructure with many different phases present in diverse morphology and in different length scale. Additionally, the matrix Co phase undergoes an allotropic phase transformation at high temperatures (as high as 1200℃ depending on alloy composition) from the low temperature hexagonal closed pack (hcp) Co structure to the high temperature face centered cubic (fcc) Co structure. In order to understand and study the complex phase relations and their effect on the mechanical properties, in the Co-Re alloy development we extensively used in-situ neutron and synchrotron measurements along with electron microscopy for the alloy development.

Through some examples in this presentation, we will show how neutron and synchrotron measurements are helping in understanding how microstructures are developed in various Co-Re alloy composition and how they evolve on exposure to high temperatures. Such information was clearly not possible with microscopic analysis of the ex-situ heat treated Co-Re alloy specimens alone and thus neutron and synchrotron probes are providing a valuable tool for the alloy development. These measurements also allow the application of loading during the in-situ measurements at the high temperatures [2] and thereby allow to simulate conditions of loading during the service in the gas turbines.

[1] J. Rösler, D. Mukherji, T. Baranski (2007), Adv. Eng. Mater 9, 876-881.

[2] L. Kargea, R. Gilles, D. Mukherji, A. Stark, P. Beran, N. Schell, M. Hofmann, P. Strunz, J. Häusler, J. Rösler, Mat. Sci. .Eng., A 719 (2018) 124–131.

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Session Classification: Parallel session 8

Track Classification: P8 Functional materials and materials science