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In-situ neutron diffraction study of Ni-addition influence on phase transformations in Co-Re-Cr high-temperature alloys

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Among new alloy systems being developed to supplement Ni-based superalloys in gas turbine applications, the Co-Re-based alloys show promise because of their excellent specific strength and relatively high melting range (1490°-1560°C). Alloying elements with various functions are added to these alloys. For example, Cr, and Ni, for oxidation resistance. Since the Co matrix undergoes an allotropic transformation from the low-temperature closed packed hexagonal structure to the high-temperature face-centred cubic structure, a two-phase matrix exists in Co-Re alloys at intermediate temperatures. Moreover, Cr addition above 20 at.%, however, pose a challenge –namely the formation of topologically closed packed Cr₂Re₃-type σ -phase. It is generally avoided in high-temperature alloys as its presence causes brittleness. The Co-Re alloys designed at TU Braunschweig are now being investigated for improving oxidation resistance and, simultaneously, suppression of σ -phase. It is intended to achieve this goal by a partial replacement of Cr with Ni atoms.

To fully reveal changes in bulky polycrystalline samples over the whole volume, in-situ neutron diffraction measurements were performed during heating to high temperatures and cooling for various Ni and Cr content alloys. The allotropic transformation of the Co-matrix and the evolution of the low-temperature hexagonal and high-temperature cubic Co phases were studied, and a phase diagram for this complex system was constructed.

Primary author: BERAN, Premysl (Nuclear Physics Institute CAS)

Co-authors: MUKHERJI, Debashis (TU Braunschweig); RÖSLER, Joachim (TU Braunschweig); KARGE, Lukas; HOELZEL, Markus; HOFMANN, Michael; STRUNZ, Pavel (Nuclear Physics Institute); GILLES, Ralph

Presenter: BERAN, Premysl (Nuclear Physics Institute CAS)

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