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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℃). 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.

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