HIGH TEMPERATURE OXIDATION BEHAVIOUR OF MO-SI-B-BASED AND CO-RE-CR-BASED ALLOYS

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Enhancing the efficiency of aerospace gas turbine engines requires materials that can be used at very high temperatures. This study summarises the current stage of alloy development of Mo-Si-B-based and Co-Re-Cr-based alloys regarding the high-temperature oxidation resistance. Since refractory metals, such as Mo and Re, suffer from catastrophic oxidation, the main task of research is to find alloying elements that improve the oxidation behaviour of these alloys. It is well-known that Mo-Si-B-based alloys are prone to catastrophic oxidation at intermediate temperature below 900°C as non-protective scales form on the metallic surface. It was found that the additions of Ti between 27 at.% and 29 at.% lead to a substitution of the Mo_3Si phase exhibiting poor oxidation resistance by Mo_5Si_3 phase showing excellent oxidation behaviour in the wide temperature range from 750°C to 1300°C. The improved oxidation resistance can be attributed to the formation of a protective duplex layer consisting of a silica matrix with embedded TiO_2 particles. Further, Ti additions cause an increased creep resistance due to the formation of Ti-rich silicides and a notable reduction of the alloy density.

In Co-Re-Cr-based alloys, Cr should fulfill a twofold task: (i) to achieve favorable mechanical properties and (ii) to form a protective chromia layer during oxidation. Unfortunately, high Cr concentrations required to assure the reliable oxidation resistance induce formation of coarse particles of the Cr_2Re_3-type σ-phase that possesses inherently poor oxidation resistance. Additionally, these coarse particles deteriorate the mechanical properties of the material. Recent efforts to adjust the microstructure of the Co-Re-Cr-based alloys reveal that Ni additions significantly refine the particle size of the σ-phase. Moreover, Ni-containing alloys show improved oxidation resistance due the formation of a protective Cr_2O_3 scale. Obviously, Ni supports the lateral growth of Cr_2O_3 nuclei and enhances the Cr diffusivity in the metallic matrix.