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HIGH TEMPERATURE ENVIRONMENTAL RESISTANCE OF MO-SI-B ALLOYS AND COATINGS

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Multiphase Mo-Si-B alloys with compositions that yield the ternary intermetallic Mo_5SiB_2 (T_2) phase as a key microstructure constituent together with the Mo and Mo_3Si phases, offer an attractive balance of high melting temperature, oxidation resistance and mechanical properties. Mo-Si-B alloys respond to high temperature oxidation in two distinct stages. First, there is a transient stage with an initial high recession rate that corresponds to the evaporation of volatile MoO_3 due to the oxidation of the molybdenum rich phases. The steady state stage of the oxidation begins when a borosilica layer that initiated in the transient period becomes continuous and protects the alloy from further rapid oxidation. Then, the oxidation rate is limited by oxygen diffusion through the borosilicate layer. In order to improve the oxidation performance of the Mo-Si-B alloys, it is necessary to minimize the transient stage. The three phases, Mo (solid solution), Mo_3Si (A15) and Mo_5SiB_2 (T_2), composing the Mo-Si-B alloys play different roles in the transient stage. The interaction of the three phases with a reduced microstructure scale can reduce considerably the transient oxidation stage. As a further approach to inhibit the transient stage, a kinetic biasing strategy has been developed to capitalize on the reactions between different phases to develop useful reaction products and alloy compositions that evolve toward a steady state of a compatible system. In order to achieve a compatible interface coating together with enhanced oxidation resistance, a pack cementation process has been adopted to apply diffusion coatings. From this basis kinetic biasing is used together with pack cementation to develop Mo-Si-B based multilayered coatings with an aluminoborosilica surface and in-situ diffusion barriers with self-healing characteristics for enhanced oxidation resistance. While a combustion environment contains water vapor that can accelerate attack of silica based coatings, the Mo-Si-B based coatings provide oxidation resistance in water vapor and resistance to CMAS attack up to at least 1500°C. An exposure to hot ionized gas species generated in an arc jet confirms the robust coating performance in extreme environments. To extend the applications beyond Mo-based systems a two-stage process has been implemented to provide effective oxidation resistance for refractory metal cermets, SiC and ZrB_2 ultra-high temperature composites.