MICROSTRUCTURE, MECHANICAL PROPERTY AND OXIDATION BEHAVIOR OF $HfZrTiTaB_x$(x=0, 1.1, 2.3, 4.7) HEAs

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The unique structural and thermal features of high-entropy alloys (HEAs) conduce to their excellent stability and mechanical properties. Recent researches have suggested that the high-entropy alloys composed of refractory metals exhibit competitive phase-stability and strength at elevated temperatures, which made them the promising candidate materials for high-temperature structural applications at even higher temperatures compared with the Ni-based superalloys. However, the alloys barely consisting of refractory metal elements are usually oxidized easily in oxidizing environment at high temperatures. This work aims to prepare a refractory HEA with both excellent mechanical properties and outstanding oxidation resistance by alloying of B element. In this study, an equimolar quaternary HfZrTiTa alloy and three kinds of $HfZrTiTaB_x$(x=1.1, 2.3, 4.7) alloys with different amounts of B-addition were produced by vacuum arc melting technique in argon atmosphere. The structures of the prepared alloys were characterized via X-Ray diffraction and TEM. The oxidation behaviors of these alloys were investigated by differential scanning calorimeter (DSC)from 25℃ to 1300℃ in air. Their mechanical properties at room temperature and phase-stability at different annealing temperatures from 800℃ to 1600℃ were also examined. The results show that the HfZrTiTa alloy consists of a fully disordered body-centered cubic (BCC) solid solution phase due to the high mixing entropy, while the alloys with B addition have some nano particles uniformly distributed in the BCC solid solution matrix. The lattice parameters and Vicker hardness of the B-containing alloys increase with increasing B content due to the interstitial solid solution strengthening of B element and nanoprecipitation strengthening. The BCC structure of all alloy samples remains stable up to 1200℃. The quaternary HfZrTiTa alloy has a flexural strength of 2.3GPa with a typical dimple fracture morphology, indicating that the alloy shows ductile to some extent. The oxidation rates of the $HfZrTiTaB_x$ (x=1.1, 2.3, 4.7) alloys at 1300℃ were about 0.13~0.15g•mm^{-2}•h^{-1}, obviously lower than that of the HfZrTiTa alloy (0.454g•mm^{-2}•h^{-1}).