EFFECT OF ZrC PHASE ON HIGH-TEMPERATURE STRENGTH AND ROOM-TEMPERATURE FRACTURE TOUGHNESS OF ZrC-ADDED Mo-Si-B ALLOYS

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Mo-Si-B-based alloys are one of leading candidate materials as ultra-high temperature structure materials. However, their high density and poor room-temperature fracture toughness have to be improved for the structural applications. Recently, we found that these problems can be solved by adding carbides such as TiC and ZrC. In this study, the high-temperature strength and room-temperature fracture toughness of ZrC-added Mo-Si-B alloys were investigated, and the effect of ZrC phase on the material properties were discussed. ZrC-added Mo-Si-B alloys (Mo-(3.2-7.0)Si-(6.5-14.0)B-(4.7-12.9)ZrC (at.%)) were prepared by arc-melting and heat-treated at 1800 °C for 24 h for homogenization. After heat-treatment, the microstructure was observed to investigate phase equilibria. Moreover, high-temperature compression tests at 1400 and 1600 °C and four-point bending tests with a Chevron notch at room temperature were conducted to investigate their mechanical properties. The constituent phases of the ZrC-added alloys were molybdenum solid solution (Mo_{ss}), Mo_{5}SiB_{2}, ZrC and a small amount of Mo_{2}B in a few cases. The density of the alloys ranged from 8.9 to 9.3 g/cm³, comparable to that of nickel-based superalloys. The alloys exhibited better high-temperature strength with relatively good deformability, for example, 1260 MPa at 1400 °C and 830 MPa at 1600 °C. The room-temperature fracture toughness of the alloys ranged from 12.4 to 20.3 MPa(m)^{1/2} depending on the volume fraction of Mo_{ss} and ZrC. River patterns were observed on fracture surfaces of not only Mo_{ss} but also ZrC phase, suggesting that ZrC also work for toughening by plastic deformation during crack propagation. Therefore ZrC plays a significant role in improving the high-temperature strength and room-temperature fracture toughness in the Mo-Si-B system.