Paragraph Ran in the Queries

Paper Title: Microstructure, mechanical properties and incipient plasticity of (Ti42.5Zr42.5Nb10Ta5)100-xMox refractory high-entropy alloys

Content :

Mechanical properties

3.2.1. Tensile mechanical property at RT

Fig. 3a presents the tensile plots of engineering stress-strain curves of the RHEAs at RT. The yield strength (σys), elongation (ε), and strength and plastic product (σys·ε) of the RHEAs are listed in Table 3. As the Mo content increases from 0 at.% to 7 at.%, the σys of RHEAs increases from 670 MPa to 975 MPa with an amplification of 45.52 %, while the ε and σys·ε increase firstly and then decrease. By contrast, the Mo5 sample possesses the most excellent comprehensive mechanical properties, which have the values of σys, ε and σys·ε of 923 MPa, 21.81 % and 20130 MPa%, respectively. Fig. 3b illustrates the fractured morphologies of the Mo0, Mo5 and Mo7 tensile samples. The fractured surfaces of the Mo0 and Mo5 samples were completely covered with ductile dimples, reflecting a typical mechanism of ductile fracture. Meanwhile, the ductile dimple of the Mo5 sample is smaller than that of the Mo0 sample. Generally, the smaller ductile dimple possesses higher strength when the alloy exhibits similar plasticity levels [26,31]. However, the fracture surface of the Mo7 sample shows a brittle feature, where the microcracks spread all around, resulting in a low plasticity.

Intrinsic plasticity or brittleness

Existing researches show that the majority of RHEAs exhibit brittleness at room temperature [[39], [40], [41]], while the Mo0, Mo3 and Mo5 samples show excellent tensile plasticity. In order to explore the plastic deformation behavior, different regions of the Mo5 tensile fracture were observed by using EBSD (Fig. 5). Here, areas a, b, c and d show the regions of 8, 6, 4 and 2 mm distances from the necking zone, respectively. The geometrically necessary dislocations (GNDs) of the Mo5 sample are shown in Fig. 5a~d, with the red regions showing high density dislocation. The increase of the GNDs occurs with the increase in strain. Meanwhile, it can be observed that high GNDs exist at the grain boundary. To be exact, the GND shows a sudden rise of $1.2 \times 10^{15}/m^2$ at grain boundaries of the area d (Fig. 5e). This uneven GND distribution between grain boundary and intragranular will facilitate a high level of plastic strain accumulation [42]. The spots 1 and 2 were selected to observe the changes in lattice orientation, where spots 1 and 2 represent different regions near the grain boundary of the same grain, respectively. The lattice orientation of the spot 1 is obviously different from that of the spot 2, indicating that the lattice around grain boundaries occurs in rotation to fit the strain distortion of grain boundaries during the tensile process [43]. Fig. 5f displays the length change of high-angle grain boundaries (HAGBs) from Fig. 5 a, b, c and d, where boundaries with >15° misorientation are defined as HAGBs. The length value of HAGBs increases with it gets closer to the necking zone. It is shown that grain boundaries absorb dislocations to form HAGBs during the deformation process, resulting in promoted plastic deformation

Compression mechanical property at high-temperature

Considering the service environment of high-temperature materials, it is crucial to assess the mechanical properties of RHEAs under high-temperatures. Fig. 7a displays the compression plots of the true stress-strain curves for the Mo5 RHEA at 1173, 1273 and 1373 K. The yield strength (YS), specific yield strength (SYS) and fracture strain (ε_f) of the RHEAs are listed in Table 4. As shown in Fig. 7a, the true stress-strain curves for the Mo5 sample increases firstly and then decreases, followed by the steady-state. Some researchers have explained that the increase of the stress-strain curves are due to work hardening, and the decreases are attributed to dynamic recrystallization [52]. The yield strengths of the Mo5 sample are 208 ± 7, 96 ± 5, and 65 ± 4 MPa at 1173, 1273 and 1373 K, respectively. Meanwhile, the fracture strains of the Mo5 sample are greater than 60 % at the three temperatures. This ensures the excellent deformability of the RHEAs. The Mo5 RHEA exhibits high mechanical performance combined with low density property (6.56 g/cm^3). The specific yield strength of the Mo5 specimen is compared with other RHEAs, as shown in Fig. 7b. The relatively high specific yield strength of the Mo5 RHEA indicates that it may be have a wider potential for industrial applications.