Paragraph Ran in the Queries

Paper Title: Observation of low friction and high wear resistance in the ductile VNbTa refractory medium-entropy alloy at 800 °C
Content :

Microstructures and mechanical properties

XRD spectrum and inset EBSD phase image in Fig. 1(a) manifest that the VNbTa alloy exhibits a single body-centered cubic (BCC) phase, agreeing well with the pioneer demonstration [21]. In addition, the bright-field TEM image and selected area electron diffraction (SAED) pattern further confirm the presence of a homogenized BCC solid-solution structure (Fig. 1(b)). Meanwhile, from the high-resolution TEM image in Fig. 1(c), the mean spacing of (110) crystal plane is determined to be about 0.2293 nm which is close to 0.2290 nm measured by XRD analysis. Fig. 1(d) illustrates the backscattered electron (BSE) image and corresponding EDS elemental maps. Obviously, the alloy possesses a representative dendritic microstructure, which is related to the solidification-induced microsegregation. EDS elemental analysis shows that the interdendritic regions are V-rich, whilst the dendritic regions are enriched with Ta element. By comparison, Nb element with medium melting temperature presents a relatively homogeneous distribution in the alloy.

Prior to the investigation of tribological performance, mechanical properties at RT and high temperatures of VNbTa alloy were evaluated. Fig. 2(a) displays the typical engineering stress-strain curves of the compression tests at RT, 800 °C and 1000 °C. Note that the yield strength at RT is determined to be 938 MPa which is in fairly good agreement with the tensile yield strength of 925 MPa reported by Han et al. [21]. And most striking, the alloy still maintains an appreciable yield strength of 609 MPa for 800 °C and 516 MPa for 1000 °C. It is worth mentioning that the superior yield strength of VNbTa alloy primarily derives from the remarkable solid solution strengthening effect [21]. In addition, there is no obvious evidence of dynamic recrystallization during hot deformation because of the excellent resistance to thermal softening [24]. Fig. 2(b) summarized the temperature dependence of yield strength of VNbTa alloy as well as several developed ductile RCCAs [[25], [26], [27], [28], [29], [30], [31], [32], [33], [34], [35], [36], [37]]. Even though some alloys have a significant loss of yield strength above 800 °C, the studied VNbTa RMEA exhibits preferable softening resistance. As a consequence, the desirable combination of strength and ductility up to 1000 °C could render it promising candidate for wear-related applications.