World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:17, No:01, 2023

Enhanced High-Temperature Strength of HfNbTaTiZrV Refractory High-Entropy Alloy via Al_2O_3 Reinforcement

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Abstract : Novel composites of HfNbTaTiZrV refractory high-entropy alloy (RHEA) reinforced with 0-5 vol.% Al_2O_3 particles have been synthesized by vacuum arc melting. The microstructure evolution, compressive mechanical properties at room and elevated temperatures, as well as strengthening mechanism of the composites, are analyzed. The HfNbTaTiZrV RHEA reinforced with 4 vol.% Al_2O_3 displays excellent phase stability at elevated temperatures. A superior compressive yield strength of 2700 MPa at room temperature, 1392 MPa at 800 °C, and 693 MPa at 1000 °C has been obtained for this composite. The improved yield strength results from multiple strengthening mechanisms caused by Al_2O_3 addition, including interstitial strengthening, grain boundary strengthening, and dispersion strengthening. Besides, the effects of interstitial strengthening increase with the temperature and is the main strengthening mechanism at elevated temperatures. These findings not only promote the development of oxide-reinforced RHEAs for challenging engineering applications but also provide guidelines for the design of light refractory materials with multiple strengthening mechanisms.

Keywords : Al_2O_3-reinforcement, HfNbTaTiZrV, refractory high-entropy alloy, interstitial strengthening
Conference Title : ICHEAAFD 2023 : International Conference on High Entropy Alloys, Applications and Future Directions
Conference Location : Singapore, Singapore
Conference Dates : January 09-10, 2023