MECHANICAL PROPERTIES OF P/M REFRACTORY HIGH ENTROPY ALLOYS

H. J. Ryu, Korea Advanced Institute of Science and Technology, South Korea
hojinryu@kaist.ac.kr
B. C. Kang, Korea Advanced Institute of Science and Technology, South Korea
O.A. Waseem, Korea Advanced Institute of Science and Technology, South Korea
J. H. Lee, Korea Advanced Institute of Science and Technology, South Korea
S. H. Hong,Korea Advanced Institute of Science and Technology, South Korea

The mechanical properties of refractory high entropy alloys are investigated to develop advanced heat-resistant alloys for high-temperature structural applications. The alloy systems were selected to have multi-principal refractory elements including, tungsten, molybdenum, niobium, vanadium, tantalum, and titanium. Mechanical alloying and spark plasma sintering were used to fabricate the WMoNbV(Ta,Ti) samples to characterize the microstructure and mechanical properties. Through powder metallurgy (P/M) processing, more precise control of compositions was possible. Crystalline structures and lattice parameters before and after sintering were measured by X-ray diffraction, and the sizes and compositions of multiple phases were measured by scanning electron microscopy, energy-dispersive x-ray spectroscopy, and transmission electron microscopy. When compared with the reported grain size of cast refractory high entropy alloys, the average grain size of P/M refractory high entropy alloys was significantly smaller.

At room temperature, the Vickers hardness and the yield strength of P/M refractory high entropy alloys were much superior to those of cast refractory high entropy alloys. The compressive yield strength of WMoNbV(Ta,Ti) ranged from 2 to 3.6 GPa with a fracture strain of 9.7 %. The previously reported compressive yield strength was 1.2 GPa with a very limited strain for cast high entropy alloys with similar compositions. The elevated temperature compressive yield strength was also enhanced in the P/M WMoNbV(Ta,Ti) alloys. Increased compressive yield strength of approximately 1 GPa was measured at 1000^{o}C. Fine-structured multi-phases with solid solution hardening were attributed to the improved mechanical properties of P/M refractory high entropy alloys.