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**Ultra-high strength WNbMoTaV high-entropy alloys with fine grain structure
fabricated by powder metallurgical process**

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Abstract

An equi-atomic WNbMoTaV high entropy alloy (HEA) with a single body-centered cubic structure (BCC) was firstly fabricated by the powder metallurgical process of mechanical alloying (MA) and spark plasma sintering (SPS). Mechanical alloying behavior, microstructure and mechanical properties of the WNbMoTaV HEA were studied systematically. During MA, a single BCC phase was formed and the average particle size and crystallite size was refined to 1.83 μm and 66.1 nm, respectively, after 6 h of MA. Afterward, the as-milled powders were subsequently sintered in the temperature range of 1500-1700°C. The microstructure of the sintered sample exhibits a few micrometer-scale grain size and a homogeneous BCC matrix with a small amount of oxide inclusion originated from oxidation during the powder metallurgical process. The bulk sample of the WNbMoTaV HEA sintered

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