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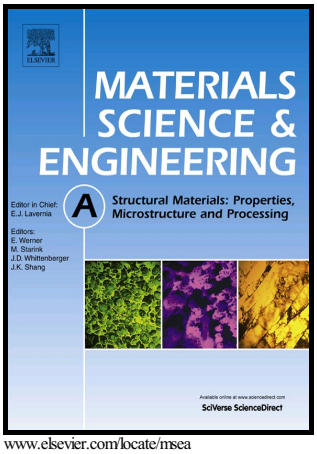


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# Microstructures and mechanical properties of $Ti_xNbMoTaW$ refractory high-entropy alloys

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## Abstract

Refractory high-entropy alloys (RHEAs) are newly developed candidate materials for high-temperature applications. Among the existing RHEAs, NbMoTaW RHEA possesses the best mechanical properties with combined high strength, excellent thermal stability and softening resistance at elevated temperatures. However, the NbMoTaW RHEA is quite brittle at room temperature, which would restrict its application as structural material. Here, $Ti_x$NbMoTaW RHEAs were developed by alloying Ti in the NbMoTaW RHEA. It shows that the room temperature ductility of the RHEAs increases from 1.9% of the NbMoTaW RHEA to 11.5% of the TiNbMoTaW RHEA, and the yield strength increases from 996 MPa of the NbMoTaW RHEA to 1455 MPa of the TiNbMoTaW RHEA. In addition, the $Ti_x$NbMoTaW RHEAs keep stable single BCC structure up to their melt points. The present result indicates that Ti addition could effectively enhance both the ductility and strength of the NbMoTaW RHEA. The combined performance of superior mechanical properties and high thermal stability of the $Ti_x$NbMoTaW RHEAs promises them an important role in engineering applications.