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タングステン合金の強度に与える試験温度およびひずみ速度の影響
The Effects of Test Temperature and Strain Rate on Strength of Tungsten Alloys

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1. Introduction

Tungsten and tungsten alloys are promising candidate materials for plasma facing components in fusion reactor. This is because of their high melting temperature, good thermal conductivity and low sputter rate. On the other hand, tungsten has the drawbacks of high ductile-to-brittle transition temperature and brittleness by recrystallization at high temperatures. Potassium (K)-doped tungsten, in which the bubbles generated in sintering process disperse, shows a higher strength and a higher recrystallization temperature than pure tungsten. Therefore, K-doped tungsten has a possibility to be more suitable as a plasma facing material in future fusion reactors.

Plasma facing materials are subjected to thermal stresses owing to the thermal gradient between their plasma-facing and cooling-channel sides. Plasma facing materials are expected to be deformed at various temperatures and strain rates since they are subjected to not only the steady state heat load but also the thermal shock of a remarkably short period. Therefore, the objective of this study is to investigate the effects of test temperature and strain rate on strength and deformation behavior of pure tungsten and K-doped tungsten, and tensile tests were performed at various temperatures and strain rates.

2. Experimental

Pure tungsten and K-doped tungsten, fabricated in the same process (i.e. powder metallurgy and hot rolling) by A.L.M.T. Corp., were used in this study. Reduction ratios of both materials were 80%. Tensile specimens were produced from the materials heat-treated at 900°C for 20 min for stress relief and their tensile direction was parallel to the rolling direction. The dimensions of the gauge section of specimens were 5 mm length x 1.2 mm width x 0.5 mm thickness.

Tensile tests were carried out in vacuum. The test temperature ranges were from room temperature to 700°C and strain rate ranges were from 10^{-5} to 10^{-1} sec^{-1}.

3. Results and discussion

The figure shows the test temperature and strain rate dependence of yield strength of pure tungsten. The specimens tested at room temperature were fractured brittle without yielding. The fracture behavior of specimens tested at 200°C changed from ductile to brittle with increasing strain rate. In the lower temperature tests, the yield strength increased with the strain rate, whereas in the higher temperature tests, there were no changes of the yield strength and the fracture behavior.

The effects of test temperature and strain rate on deformation behavior and the results of K-doped tungsten will be discussed.

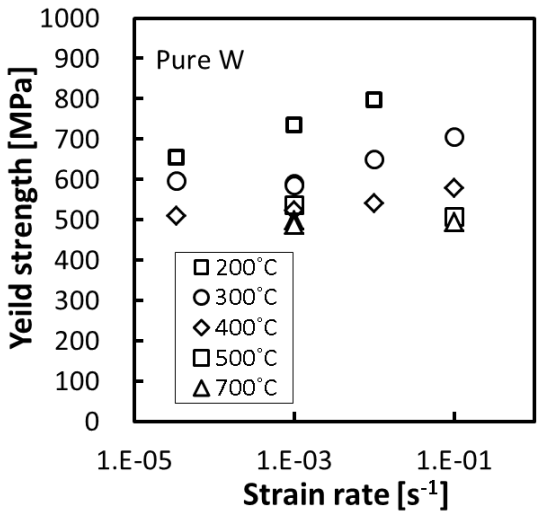

Fig. Test temperature and strain rate dependence of yield strength of pure tungsten.