6Dp03

低温脆性と再結晶脆化の抑制を目指した タングステン合金およびその複合材料の開発

Development of Tungsten Alloys and Their Composite to Suppress Low Temperature Brittleness and Recrystallization Embrittlement

野上修平[1]，間偉文[1]，渡邊捷太郎[1]，能登裕之[2]，Jens Reiser[3]，Michael Rieth[3]，
長谷川晃[1]，宮澤健[1]，長坂琢也[2]
S. NOGAMI[1], T. HAZAMA[1], S. WATANABE[1], H. NOTO[2], J. REISER[3], M. RIETH[3],
A. HASEGAWA[1], T. MIYAZAWA[1], T. NAGASAKA[2]

[1]東北大・工，[2]NIFS，[3]KIT
[1]Tohoku Univ., [2]NIFS, [3]KIT

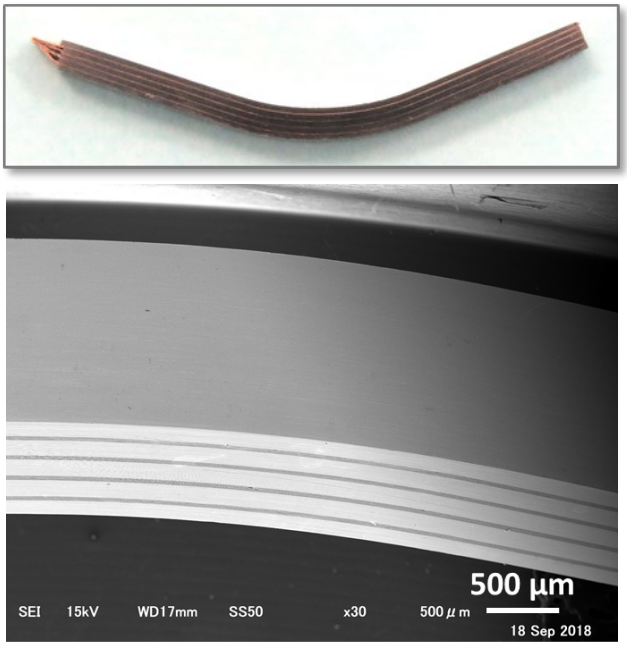
Tungsten (W) is a primary candidate of plasma facing material of fusion reactor divertor because of its high melting point, thermal conductivity, sputtering resistance, and low tritium retention. However, there remain some drawbacks of the mechanical properties of W materials, which are low temperature brittleness, high ductile-to-brittle transition temperature (DBTT), and recrystallization-induced embrittlement.

To improve these mechanical properties of W, potassium (K) doping and alloying by rhenium (Re) have been applied as dispersion strengthening and solid solution softening/strengthening methods, respectively in our research. In this presentation, the effects of K-doping and Re-addition on mechanical properties and recrystallization behaviors of W materials fabricated by powder metallurgy and hot rolling will be discussed.

It is known that highly deformed W foils show ductility even at room temperature. However, their potential issue is material thickness (volume) for divertor application. To satisfy both low temperature ductility and material volume, pure W foil laminate has been developed, which is a composite material consisting of stacked thin pure W foils with room temperature ductility and interlayer material. In general, highly deformed materials show low resistance to recrystallization. Therefore, W foil laminate using K-doped W, which can suppress recrystallization compared to the pure W, is newly developed in our research. In this presentation, the fracture behavior of K-doped W foil laminate using pure vanadium (V) and copper (Cu) interlayers will be discussed and the feasibility of W foil laminate to further improve low temperature ductility compared to the bulk W materials will also be discussed.

It is clarified that the suppression of low temperature brittleness, lowering the DBTT, and suppression of recrystallization, which are issues of mechanical properties of W materials for divertor application of fusion reactor, can be simultaneously improved by the K-doping and alloying by Re. The DBTT and recrystallization temperature of pure W, K-doped W, and K-doped W-3%Re were 550 ºC / 1200 ºC, 350 ºC / 1300 ºC, 250 ºC / 1500 ºC, respectively.

Further improvement of the low temperature ductility compared to the bulk W materials was obtained by laminate. As shown in the following picture, the K-doped W foil laminate showed room temperature ductility under bending test.



After 4pt bending test at R.T.