Transactions of the Korean Nuclear Society Autumn Meeting
Jeju, Korea, May 12-13, 2016

Reduced Activated W Alloys for Plasma Facing Materials

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1. Introduction

In order to be realized nuclear fusion as a future energy, it is essential to develop plasma facing materials which can withstand harsh environment over the long term. Compared with other materials, tungsten has many advantageous properties in a plasma environments. For examples, tungsten has the merit of very low sputter erosion under bombardment by energetic particles like D, T, He ions from the plasma. And it also is high melting point and high thermal conductivity which is good properties for resisting to high thermal load [1].

A potential problem with using pure tungsten in a fusion reactor is the formation of WO3 which is radioactive and highly volatile compound and there is possibility that it may get released under accidental scenario.[2] A feasible way for avoiding this is developing a self-passivating oxide layer at the surface of tungsten.

Therefore, self-passivating W based alloys are developed. There are studies to create new composition of alloys for self-passivating and a variety of ternary system have been reported.[3] Among them we developed W-Cr-Ti system alloys with changing composition using powder metallurgy.

2. Methods and Results

2.1 Methods

The powders of W, Cr and Ti were mixed by 2 different ways with 2 different composition. In method, One is high-energy ball milling and another one is mixing to develop tungsten-based self-passivating alloys. And in composition, one is WCr14Ti2 (in wt.%) and another one is WCr18Ti2 (in wt.%). Therefore the total samples which is studied are four. The high-energy ball milling was carried out with in a TC jar at 300 rpm for 40 hours and ball to powder ratio is 1:1. The mixing was carried out with in a plastic bottle at 30 rpm for 4 hours. Sintering was done at 1450 ^{O}C and 50 MPa for 10 minutes. The XRD, SEM and EDS was done.

2.2 Results

The microstructures of W-Cr-Ti self-passivating alloys, as shown in Fig. 1, shows 3 kinds of phases in each sample. In all four samples, the amount of dark phase is very small. In high-energy ball milling samples (H), it seems that grey phases forms the background. On the other hand, in mixing samples (M), the background phase is white phase. EDS results shows presence of dark Ti rich phase in bright W rich matrix.

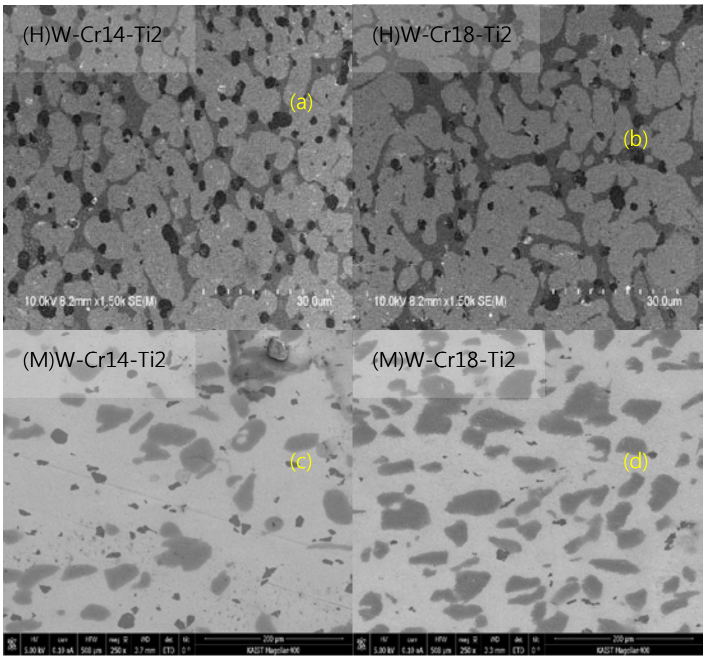

Figure 1. SEM micrographs of two different type of W-Cr-Ti system. (a) and (b) are images of samples which were made by high-energy ball milling. (c) and (d) are images of samples which were made by mixing.

The results of hardness test, as shown in Fig. 3, illustrates enhanced hardness. It can also be observed that by changing composition by varying W content from 90% to 40.

The results shows that W-Cr-Ti alloy can be successfully developed by 2 different method, high-energy ball milling and simple mixing

3. Conclusions

The results shows that W-Cr-Ti alloy can be successfully developed by 2 different method, high-energy ball milling and simple mixing. The W-Cr-Ti alloy shows. By SEM and EDS. shows Ti and W rich phases. The HEA showed much higher hardness than pure W. which shows its usefulness in fusion applications.

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