Study on microstructure change of Uranium nitride coated U-7wt%Mo powder by heat treatment

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1. Introduction

Uranium-molybdenum alloy particle dispersion fuel in an aluminum matrix with a high uranium density has been developed for a high performance research reactor in the RERTR program.

In order to retard the fuel-matrix interaction in U-Mo/Al dispersion fuel in which the U-Mo fuel particles were dispersed in Al matrix, nitride layer coated U-Mo fuel particle has been designed and techniques to fabricate nitride-layer coated U-7wt%Mo particles have been developed in our lab.

In this study, uranium nitride coated U-Mo particle has heat treatment for several times and degree. And we suggested for interaction layer remedy in U-Mo dispersion fuel. We investigate effect of heat treatment interaction layer evolution on uranium nitride coated U-Mo powder.

The EDS and XRD analysis to investigate the phase evolution in uranium nitride coated layer is also a part of the present work.

2. Experimental and Results

The vacuum rotator heat treating furnace (VRHF) was developed to coat nitride layer on the surface of U-7wt%Mo powders. Centrifugally atomized U-7wt%Mo powder with 50-90 ㎛ in diameter was used for nitride coatings. About 20 g of U-7wt%Mo powder was loaded in the crucible and heated to 820, 920℃ in vacuum.

And about 10 g of uranium nitride coating U-7wt%Mo powder was loaded in the crucible and heated to 1000℃ in vacuum for 2,4,6 hours.

The effect of annealing time on the nitride layer growth and phase evolution in the coated layer were examined. Microstructure change of uranium nitride coating U-Mo particle be observed by heat treatment furnace. Phase of coated fuel particles and heat treated uranium nitride U-Mo particle were investigated by using X-ray diffractometer. Cross-sectional microstructures of the diffusion couple specimens were observed by using scanning electron microscopy (SEM). The elemental composition of the interaction layers were measured by using energy dispersive X-ray spectroscopy (EDS) and standardless quantitative data were obtained.

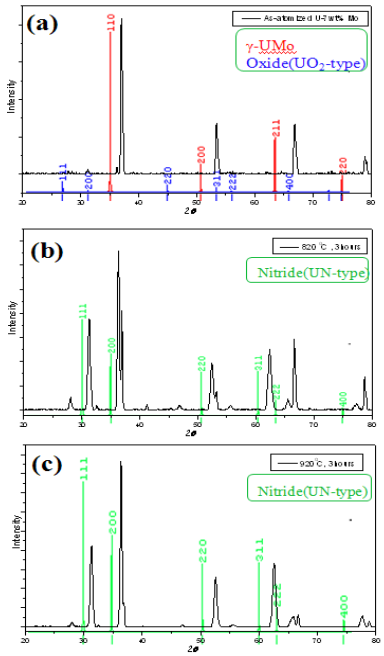

Fig1. X-ray diffraction patterns for (a) as centrifugally atomized U-7wt%Mo powder and nitride coated powders obtained by annealing at (b)820, (c)920℃ for 3h.

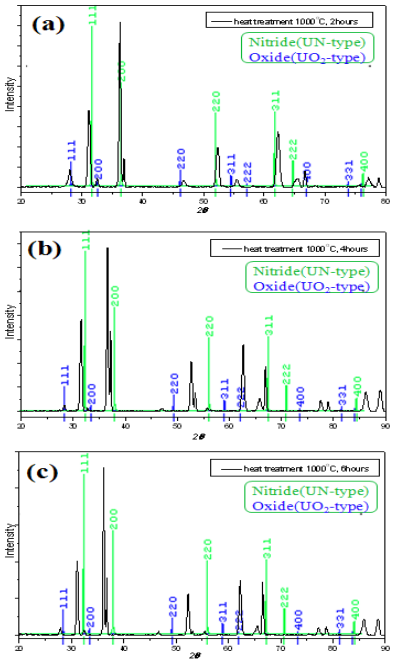

Fig2. X-ray diffraction patterns uranium nitride coated

powders obtained by heat treatment 1000℃ for (a)2h, (b) 4h, (c)6h.

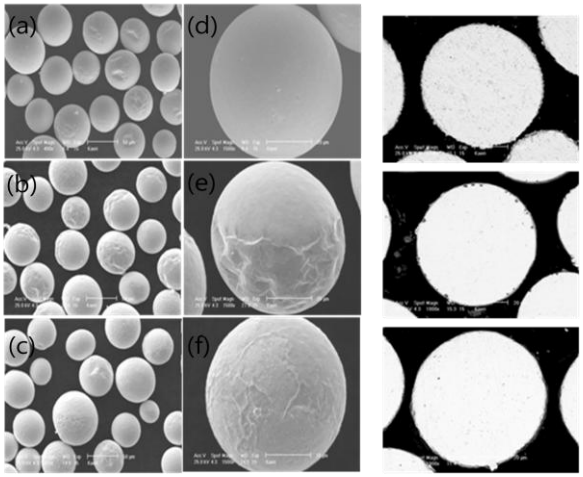

Fig3. A scanning electron micrograph for (a,d)as centrifugally atomized U-7wt%Mo powder and nitride coated powders obtained by annealing at (b,e)820℃, (c,f)920℃ for 3h under vacuum. Microstructures of (g) as centrifugally atomized U-7wt%Mo powder and (h,i)nitride coated powders after annealing.

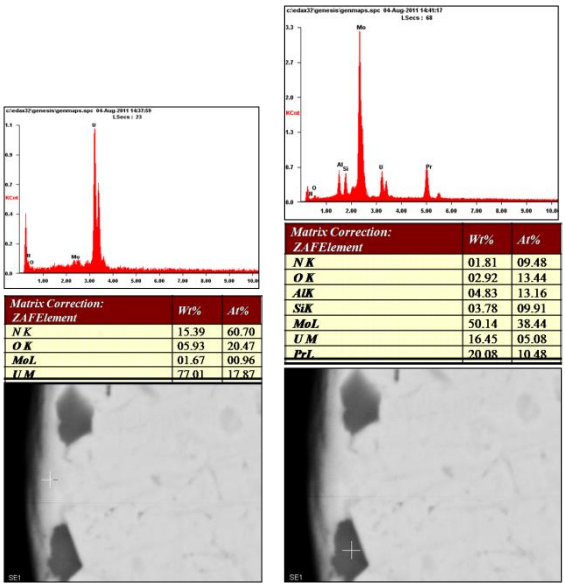

Fig4. A cross-sectional scanning electron micrograph of uranium nitride coated U-7wt%Mo powder at 820℃ for 3 hour under vacuum.

3. Conclusions

Direct nitriding process of U-7wt%Mo particles has been investigated to fabricate the nitride layer coated U-7wt% Mo particles by using the lab-made VRHF equipment. The effect of annealing time on the nitride layer growth and phase evolution in the coated layer were examined.

Uranium nitride (UN, UN_2) layers were formed successfully on the surface of U-7wt% Mo powder after annealing at 820, 920℃ in N_2 gas atmosphere. And we will research unique phase in interaction layer by heat treatment.

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