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Effect of BN Content on the Sintered Density of Boron-containing Burnable Absorber Fuel Pellet

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1. Introduction

Boron is a commercially-used neutron absorber which can be burned out or depleted during reactor operation. Boron is used as an Integral Fuel Burnable Absorbers (IFBAs). It is known that IFBA fuel can incur 20% to 30% additional fabrication costs. [1]

As for the manufacturing costs, it is cost-effective to sinter a green pellet which is made of a powder mixture of UO_2 and B compound. M. G. Andrew et al. [2] reported that boron-dispersed UO_2 fuel pellet is very difficult to be fabricated with a sufficient level of boron retention and high sintered density (greater than 90 % of theoretical density) because of the volatilization of boron oxide.

However, our previous study [3,4] showed that BN seemed to act as a sintering additive at a certain low temperature range.

In this study, we are trying to fabricate the boron-containing UO_2 pellet by using a mixture of UO_2 powder and BN powder in a sintering atmosphere of H_2 gas. We have investigate the effect of BN content on the sintered density of BN-containing UO_2 pellet according to the sintering temperature and time.

2. Experimental

Samples were prepared with ADU route UO_2 powder and 70 nanometer-sized BN powder. UO_2 powder was mixed with 0.1 - 1 wt% of BN powder in a ball mill for 24 h using an ethanol medium. A dried powder mixture was granulated with a 30 mesh sieve. The granules were mixed with a 0.3 wt% of zinc stearate in a tumbling mixer for 30 min. The compaction was conducted in a single acting press under about 3 ton/cm^2. The powder compacts were sintered at 1100 °C and 1200 °C for 1 to 4 h in a H_2 atmosphere. The sintered density was measured by a water immersion method. Microstructures were observed using an optical microscope after polishing the cross-section of the sintered pellet up to a 1 μm diamond polish.

3. Results

Figure 1 shows the sintered density changes according to initial BN contents in UO_2 green pellets, sintering temperature and time. The sintered density of BN added UO_2 pellet is higher than that of pure UO_2 pellet. Even an addition of 0.1 wt% BN appears to increase the sintered density of UO_2 pellet considerably.

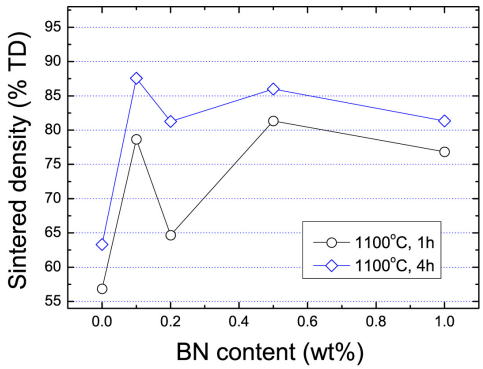

Fig. 1. Sintered densities of BN containing UO_2 pellets with various BN contents.

The sintered density gradually decreases in samples with more than 0.2 wt% of BN added. The sintered density increases with the sintering temperature and time increased. Appropriate sintered density of burnable absorber pellet, greater than 90 % of theoretical density, which is suggested in the previous study [2] appears to be achieved when we sintered the 0.1 to 0.5 wt% BN added UO_2 at 1200 °C for more than 1 h in a H_2 atmosphere.

4. Conclusions

A boron-containing UO_2 pellet with a high density of greater than 90 %TD can be manufactured after sintering at 1200 °C for more than 1 h in a H_2 atmosphere. A small amount of BN seemed to enhance material transfer during sintering at a certain low sintering temperature in a H_2 atmosphere.

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