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Resintering Test of Micro Structural Controlled UO_2 Annular Pellet

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1. Introduction

To increase the economic efficiency of nuclear power generation, the development of an innovative nuclear fuel for a high burnup and extended cycle is necessary. It must be considered both uprating a power of nuclear reactor and increasing the safety margin of nuclear fuel, simultaneously. One of the best ways is a new fuel geometry design that is of an annular shape pellet and its inner and outer cladding, and has the geometry design of both an internal and external cooling system (dual cooled nuclear fuel) [1].

The dual cooled fuel is being developed by KAERI. Also, as a part of the project, the development of a fabrication technology of an annular pellet is now in progress.

In the development of a fabrication technology of an annular pellet for dual cooled fuel, it is important that a dimensional tolerance of an annular pellet satisfied with a fuel design criteria. Therefore, to find an optimized fabrication method for an annular pellet, we have considered and investigated the various technology.

In this study, a microstructure of UO_2 annular pellet was controlled by using pore former (AZB) addition. And then, a resintering test [2-4] of the micro structural controlled annular pellet was performed. Finally, the dimensional and density change of pellet due to the resintering were observed by a precise measurment.

2. Experimental

ADU-UO_2 (Ammonium Diuranate) powder was granulated with a pressure of 70 MPa and a 20 mesh (aperture: 850 μm) sieve. The granulated powder was mixed with 0.5 to 4.0 wt% of a pore former (8 μm AZB, Azodicarbondiamid) by using a Turbula mixer for 0.5 h. For homogenious mix, the mixed powder was sieved by using sieve and shaker. And it was mixed with a lubricant powder (0.3 wt% zinc stearate).

The powder mixture was compacted by using a double acting press, and sintered at 1730 ℃ for 4h in a flowing H_2 atmosphere. And then, the sintered annular pellets were resintered at 1700 ℃ for 24h in a flowing H_2 atmosphere.

The sintered and resintered density of the annular pellet was determined by using an immersion method, and the dimensions of the annular pellet were measured by using a 3-dimensional precise measuring system (VERTEX 230, MicroVu).

3. Results

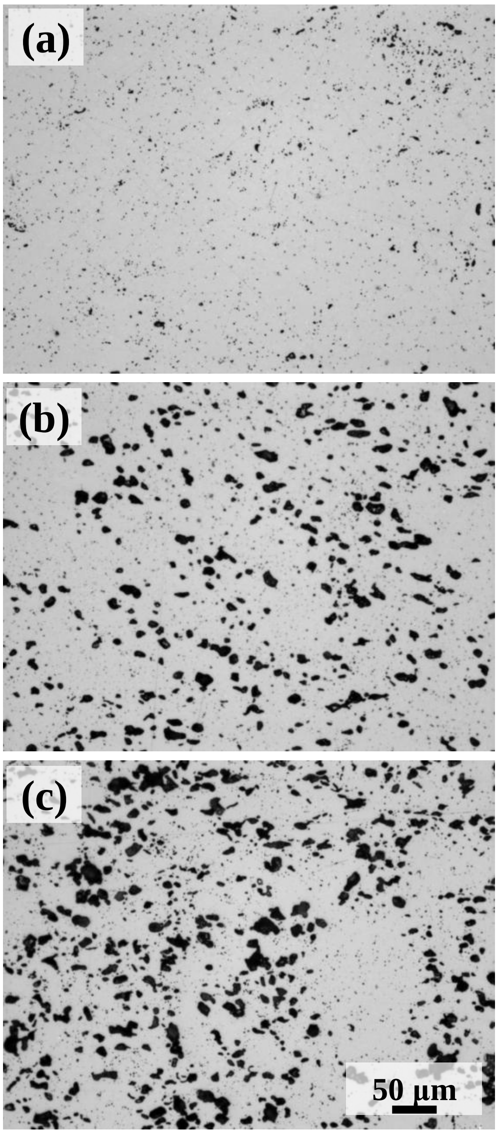

Figure 1. The optical microscopic image (×200) of sintered UO_2 annular pellets: (a) 0 wt%, (b) 2 wt%, (c) 4 wt% pore former (AZB).

Figure 1 shows a microstructure of the sintered annular pellet. The number of large pore increased with increasing pore former contents. Especially, in case of 2 and 4 wt% of pore former addition, the pore channels that connected with the outer surface of the annular pellet were observed (Figure 2).

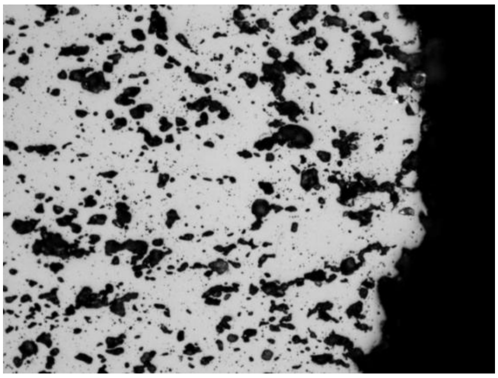

Figure 2. The optical microscopic image (×200) of sintered UO_2 annular pellet (4 wt% AZB added). The pore channels are connected with the outer surface of the pellet.

Figure 3 shows the sintered and resintered density of the annular pellet as a function of AZB contents. In the low contents of AZB, the resintered density of annular pellet was slightly higher than the sintered density. However, the magnitude of the density change was less than 1%TD. In the high contents of AZB, the density change between sintered and resintered annular pellet was not revealed.

Figure 4 shows the outer diameter of the sintered and resintered annular pellet as a function of pore former contents. Both outer and inner diameter of every specimen were measured and compared. The outer diametric change of annular pellet was below 10 μm.

In the results, it can be concluded that the density and diameter of annular pellet were hardly changed in the resintering test, because the matrix of pellet had already a high density through the sintering stage. That is to say, regardless of pore former contents, the matrix density of each pellet was similarly high. So, there was little density and diameter change.

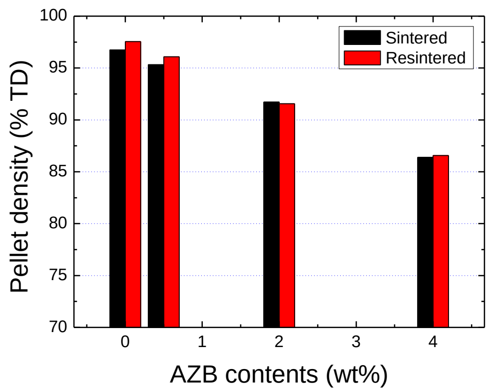

Figure 3. The sintered and resintered density of the annular pellet as a function of AZB contents.

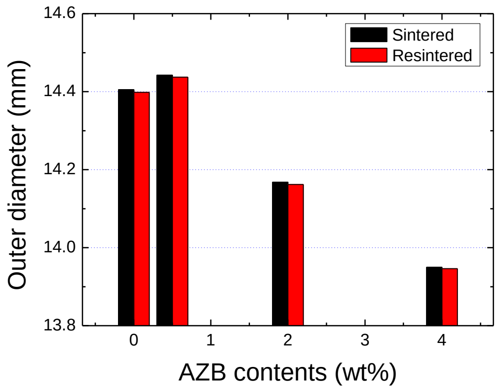

Figure 4. The outer diameter of the sintered and resintered annular pellet as a function of AZB contents.

4. Summary

The micro structure of UO_2 annular pellet was controlled by using pore former (AZB) addition. The resintering test of the micro structural controlled annular pellet was performed. The density and diametric change between sintered and resintered annular pellet was compared by using a precise measurement. In the results, regardless of pore former contents, there was little density and diameter change of the annular pellet.

ACKNOWLEDGEMENT

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