Dimensional Change of Annular Pellet Fabricated using U_3O_8-UO_2 Powder Mixture

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1. Introduction

To increase the economic efficiency of a 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 to do this is a new fuel geometry design that is of an annular shape pellet in 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 Korea Atomic Energy Research Institute (KAERI). Also, as a part of the project, the development of a fabrication technology of an annular pellet is now in progress [2].

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.

During a typical pellet fabrication process, fairly amount of defective UO_2 pellets are produced and it is necessary to recycle the scraps. Generally, the defective scraps are powdered through the air oxidation and then mixed with co-milled powder, and further processed to fabricate UO_2 pellets [3-5].

In this study, the dimension and dimensional tolerance change of U_3O_8 added UO_2 sintered annular pellet was observed. And then, a resintering test [6] of the fabricated annular pellet was performed.

2. Experimental

ADU-UO_2 (Ammonium Diuranate) powder was granulated with a pressure of 70 MPa and a 20 mesh (aperture: 850 μm) sieve. U_3O_8 powder was prepared by heating UO_2 pellets in flowing air at 400°C for 3 h. The granulated UO_2 powder was mixed with the prepared U_3O_8 powder (0~10 wt%) by using a Turbula mixer for 0.5 h. And it was mixed with a lubricant powder (0.3 wt% zinc stearate).

The U_3O_8-UO_2 powder mixture was compacted by using a double acting press, and sintered at 1730 ºC for 4h in a flowing H_2 atmosphere. And then, the sintered annular pellets were resintered at 1700 ºC 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

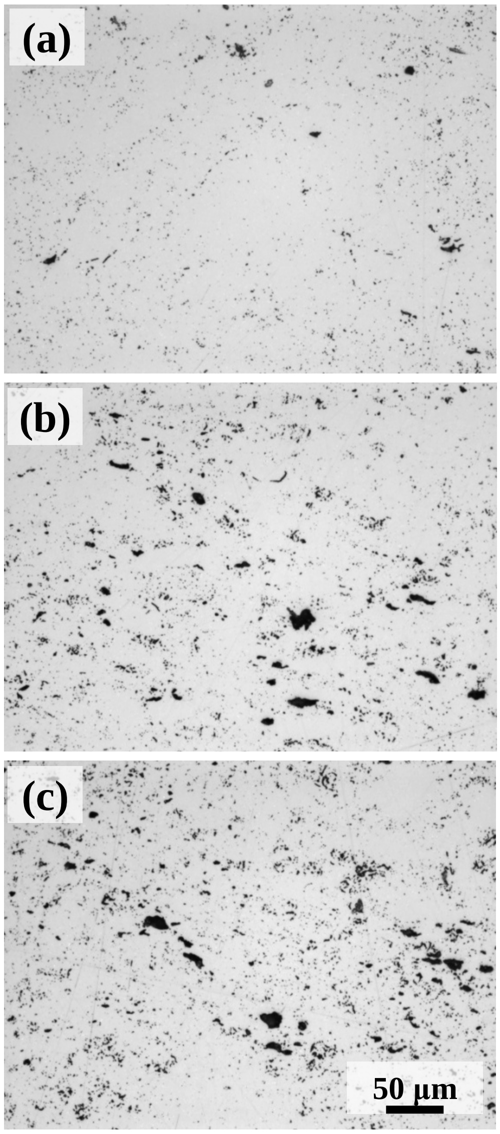

Figure 1. The optical microscopic image (×200) of sintered UO_2 annular pellets: (a) 0 wt%, (b) 6 wt%, (c) 10 wt% U_3O_8 powder added.

Figure 1 shows a microstructure of the sintered annular pellet fabricated using the U_3O_8-UO_2 powder mixture. The number of large and small pore increased with increasing U_3O_8 contents. In the U_3O_8-added annular pellet, group of small pore (trace of U_3O_8 powder) could be observed.

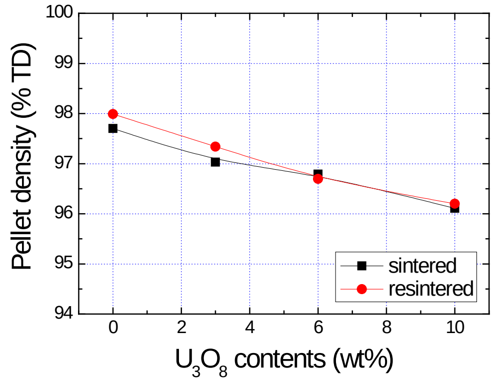

Figure 2. The sintered and resintered density of the annular pellet as a function of U_3O_8 contents.

Figure 2 shows the sintered and resintered density of the annular pellet as a function of U_3O_8 contents. The density of annular pellet decreased with increasing U_3O_8 contents, because of the formed pore in the pellet due to U_3O_8 powder. On the other hand, density change of the annular pellet during a resintering test was little.

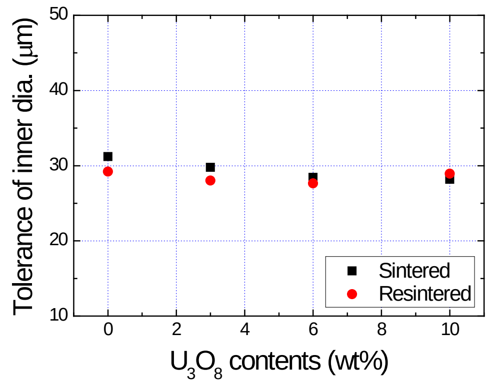

Figure 3. The tolerance of inner diameter of sintered and resintered annular pellet as a function of U_3O_8 contents.

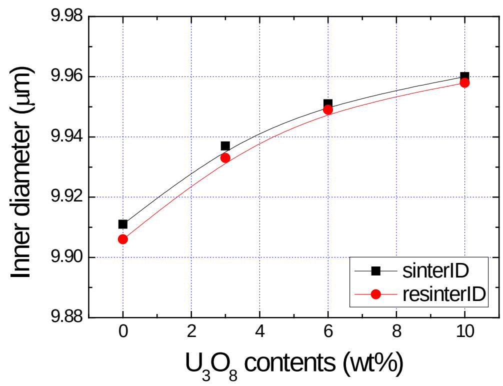

Figure 4. The inner diameter of sintered and resintered annular pellet as a function of U_3O_8 contents.

The inner diametric tolerance of sintered and resintered annular pellet as a function of U_3O_8 contents is shown in Figure 3. There was little influence of the U_3O_8 addition on the tolerance of annular pellet.

Figure 4 shows the inner diameter of the sintered and resintered annular pellet as a function of U_3O_8 contents. The inner diameter of the annular pellet increased with increasing U_3O_8 contents.

4. Summary

The effect of U_3O_8 addition on the density, dimension and dimensional tolerance of annular pellet was experimentally observed. In the results, it could be observed that the tolerance of inner diameter of annular pellet hardly changed due to U_3O_8 addition. However, inner diameter of annular pellet increased with increasing U_3O_8 contents. Therefore, to recycle the scrap U_3O_8 powder, an effort to maintain a constant inner diameter is needed. Also, the minimization of inner diametric tolerance is simultaneously needed.

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