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Effect of a DM treatment on the sinterability of $(U,Ce)O_2$

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1. Introduction

Milling of a powder enhances the sinterability, resulting in a large and homogeneous grain structure of the pellet. In general, it is known that the characteristics of a powder depend largely on the particle size of the powder, and both the compactability and sinterability of a powder are affected by its size. There are many pulverizing devices to minimize the particle size, such as a ball mill[1], DM(Dynamic Mill)[2], hammer mill[3], CAM(Continuous Attrition Mill)[4], etc. Both the DM and CAM devices were devised by KAERI(Korea Atomic Energy Research Institute). Among these mills, especially, DM, hammer mill and CAM have been reported to have a large effect on the milling and homogenizing of a powder mixture with an increasing sintered density[2-4].

In this study, CeO_2 powder was used instead of PuO_2 powder. Nuclear chemical properties of CeO_2 are similar to those of PuO_2. The effect of the DM milling time(0.5~8 hrs) on the sintered density and microstructure of the (U, Ce)O_2 [CeO_2 :3~10 wt%] pellet was investigated.

2. Experimental method

Fig. 1 shows a schematic DM(Dynamic Mill). The DM jar revolves at 25 rpm. Zirconia ball(dia. 8 mm) loaded into the jar with 70% of the volume of the jar. Sample size is 50 g of a $(U,Ce)O_2$ powder mixture. Fig. 2 shows a fabrication flow sheet of the $(U,Ce)O_2$ pellet. As shown in this figure, the sintered (U, Ce)O_2 [CeO_2 content : 3~10 wt%] pellet specimens were prepared by the DM device with various milling times. And the relevant details(powder preparation, fabrication condition, etc) are given in this figure.

3. Results and discussion

1) Sintered density of the (U, Ce)O_2 pellet

Fig. 3 shows the sintered density of the (U, Ce)O_2 pellet with various CeO_2 additive contents and DM milling times. As shown in this figure, the sintered density of (U, Ce)O_2 increased as the additive content of CeO_2 increased under the same DM milling time. But the sintered density decreased above 7.5 wt% of the CeO_2 content. As time passed, the sintered density of $(U,Ce)O_2$ increased with an increasing DM milling time. But regardless of the CeO_2 content, the sintered density was almost saturated with a 99%T.D. above 3 hrs of DM.

2) Microstructure of the (U, Ce)O_2 pellet

The average grain size of the (U, Ce)O_2 sintered pellet increased as the DM milling time increased under the same additive content of CeO_2. Fig. 4 shows the microstructures of the (U, Ce)O_2 pellet with varying DM milling times. However, as the DM milling time decreased, a cored structure with a large grain size around the periphery and a small grain size within the body of the pellet appeared. It is consider that the DM treatment has a strong effect, that creates a large and homogeneous grain structure of the $(U,Ce)O_2$

sintered pellet. As time passed, it appeared that the grain size of the $(U,Ce)O_2$ pellet scarcely was affected by the additive content of CeO_2. For example, the mean grain sizes of the $(U,Ce)O_2$ pellets prepared from the 8-hr of DM milling time were measured in the range of 12 to 14 ㎛, regardless of the additive content of CeO_2.

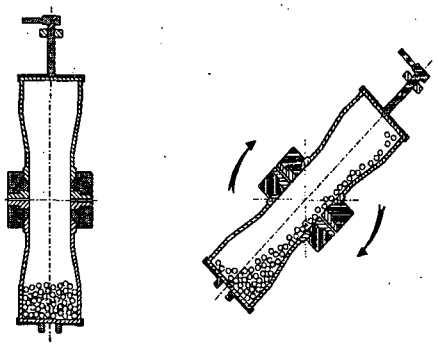

Fig. 1. Schematic diagram of a Dynamic Mill

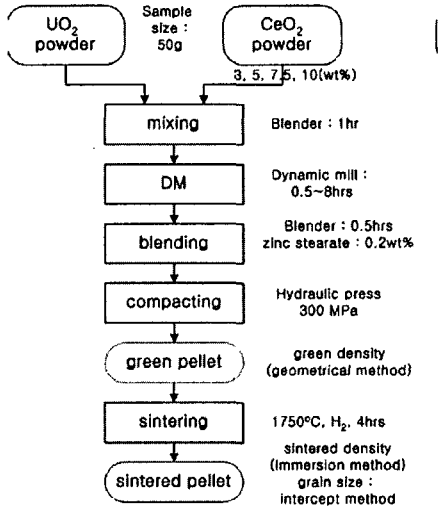

Fig. 2. Schematic fabrication flow sheet of a $(U,Ce)O_2$ pellet

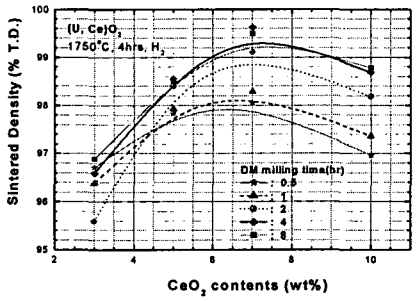

Fig. 3. The sintered density of the (U,Ce)O2 as a funtion of the CeO2 content.

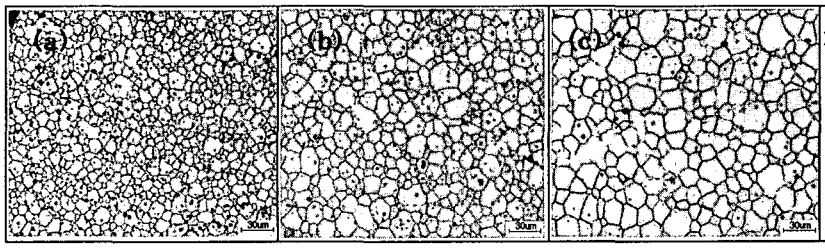

Fig.4. Microstructures of UO_2-7.5wt%CeO_2 pellets with various milling times.
(a) DM : 2hrs(6.16㎛)
(b) DM : 4hrs(9.55㎛)
(c) DM : 8 hrs(12.26㎛)

3. Conclusion

Results of the experiments described in this work lead to the following conclusions :

- The grain size of the $(U,Ce)O_2$ pellet increases with an increasing milling time.
- As the milling time increases, the grain size distribution of the $(U, Ce)O_2$ pellet appears to be more homogeneous.

Acknowledgements

This work was performed under the long-term nuclear R&D program sponsored by the Ministry of Science and Technology

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