Fabrication of Ternary Oxide, (U, Ce, Gd)O_2

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1. Introduction

MOX(Mixed Oxide), (U, Pu)O_2, is an alternative nuclear fuel to increase uranium efficiency and to use recycled plutonium in the nuclear power reactors. The increased content of PuO_2 leads to a high burn-up. Gadolinia, Gd_2O_3, is an efficient neutron absorber, and the solid solution type of UO_2-Gd_2O_3 has been widely used as a burnable poison in most nuclear power reactors[1,2]. However, few study on the fabrication of MOX-Gd_2O_3 fuel has been reported[3].

In this work, feasibility of fabrication of ternary system oxide, UO_2-10wt%CeO_2-Gd_2O_3(4, 6wt%) is examined. CeO_2 powder was used as surrogate of PuO_2, owing to its high temperature material properties.

2. Methods and Results

2.1 Experimental methods

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 50g of a UO_2-10wt%CeO_2-Gd_2O_3 powder mixture. Fig. 2 shows a fabrication flow sheet of the (U,Ce,Gd)O_2 pellet . And the relevant details(powder preparation, fabrication condition, etc) are given in this figure. The sintered density and grain size of these sintered pellets are determined from an immersion method and a linear intercept method, respectively.

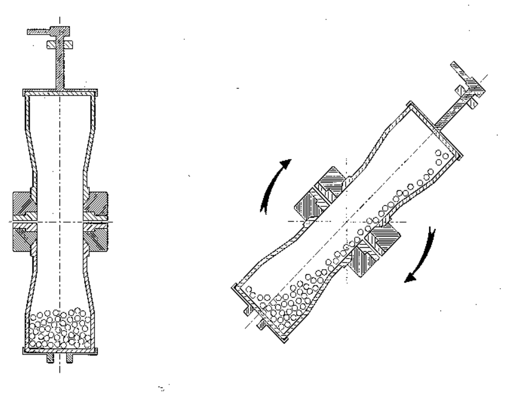


Fig. 1 Schematic diagram of a Dynamic Mill

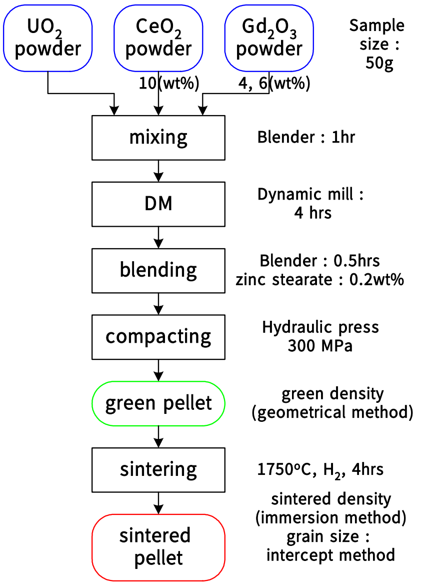


Fig. 2. Fabrication flow sheet of (U,Ce,Gd)O_2 pellet

2.2 Results and discussion

Fig. 3 shows sintered densities and grain sizes of UO_2-10wt%CeO_2-Gd_2O_3 as a function of Gd_2O_3 content. As shown in this figure, sintered densities of UO_2-10wt%CeO_2-Gd_2O_3 show higher densities(about 97.5%T.D.) and larger grain sizes(about 17~18μm), regardless of content of Gd_2O_3. Fig. 4 shows the microstructures of (U,Ce,Gd)O_2 sintered pellet. This figure shows an uniform and homogeneous grain structure with different contents of Gd_2O_3. Therefore, in view of fabrication process, it is thought to be possible to fabricate this ternary oxide sintered pellets, which have good physical properties.

3. Conclusion

The feasibility of fabrication on the ternary oxide, (U, Ce, Gd)O_2 was studied. Results are as following.

- The sintered densities and grain sizes of UO_2-10wt%CeO_2-(4, 6wt%) Gd_2O_3 sintered pellet show high values as much as other binary oxides.
- Therefore, it is possible to fabricate the (U, Ce, Gd)O_2 pellet which has good quality, and a similar

result can be expected when PuO_2 is used instead of CeO_2.

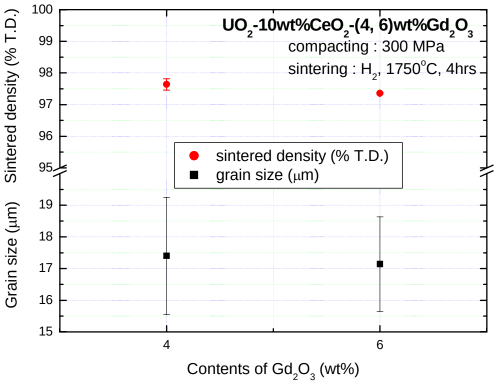
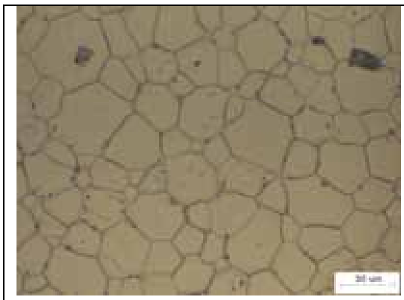
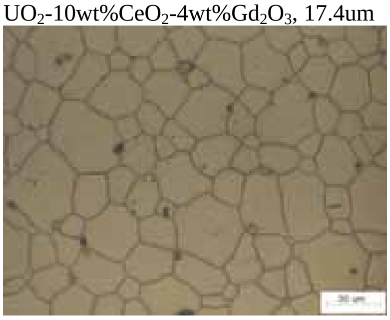


Figure 3. Sintered density and grain size of UO_2-10wt%CeO_2-Gd_2O_3 as a function of Gd content.



UO_2-10wt%CeO_2-4wt%Gd_2O_3, 17.4um



UO_2-10wt%CeO_2-6wt%Gd_2O_3, 17.1um

Fig. 4. Microstructures of UO_2-10wt%CeO_2-Gd_2O_3 as a function of Gd_2O_3 content.

REFERENCES

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[3] M. Gato, S. Kohno and K. Kamimura, IAEA Tech. Committee Mtg. on Advances in Pellet Technology for Improved Performance at High Burnup, Tokyo, Japan. 28 Oct-1 Nov., 1996

Acknowledgement

This work has been carried out under the Nuclear R & D program by the Ministry of Science and Technology (MOST), Korea.