Sintering Characteristics of High Content Gd-bearing UO_2

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1. Introduction

Gadolinia is an efficient neutron absorber and widely used as a burnable poison in most nuclear power reactors[1,2]. Higher content Gd-bearing UO_2 fuels are needed to meet the high burn-up and the longer cycle operation. However, it is known that the manufacturing of high content Gd-bearing UO_2 pellet is not easy due to the solubility of Gd_2O_3 in UO_2.

In this work, sintering characteristics are investigated on the high content Gd-bearing UO_2 pellet(10, 12 and 15 wt%) with different cycles of CAM(Continuous Attrition Milling).

2. Methods and Results

With two different milling cycles (5 and 10 cycles) of CAM and three different Gd contents(10, 12 and 15 wt%), (U,Gd)O2 pellet specimens are prepared, as shown in Fig. 1. And details(powder preparation, fabrication condition, etc.) are given in this figure.

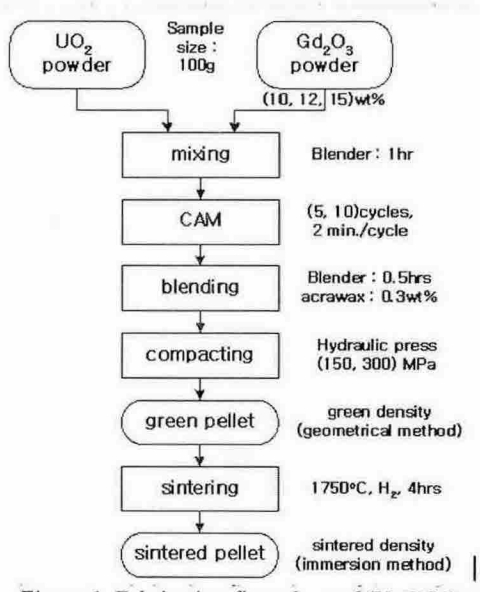

Figure 1. Fabrication flow sheet of (U, Gd)O_2 pellet

2.1 Effect of Compacting Pressure

Fig. 2 shows variation of the percent theoretical density(%T.D.) of (U, Gd)O_2 sintered pellet with the two different compacting pressures under the constant milling cycle(5 cycles). As shown in this figure, the %T.D. of (U,Gd)O_2 sintered pellet increases with increasing compacting pressure. However, its increment decreases with increasing Gd content. It is considered that the amount of free Gd increases as the Gd content increases due to the solubility limit of Gd_2O_3 in UO_2.

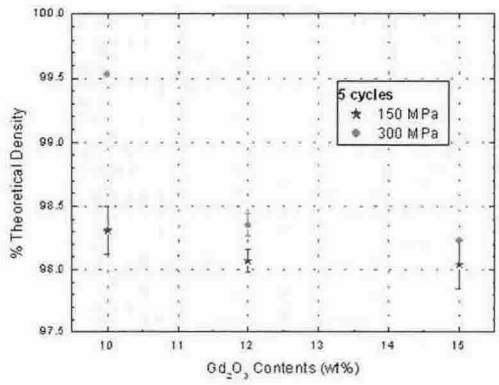

Figure 2. Sintered density vs. Gd content with different compacting pressure.

2.2 Effect of Milling Cycles

Fig. 3 shows a variation of %T.D. of (U, Gd)O_2 sintered pellet with the two different milling cycles (5 and 10 cycles) of CAM under the constant compacting pressure (300 MPa). As shown in this figure, the %T.D. of (U, Gd)O_2 sintered pellet is decreased with increasing milling cycles of CAM. It is thought that characteristics of UO_2-Gd_2O_3 powder mixture are no more affected by milling cycles above 5 milling cycles.

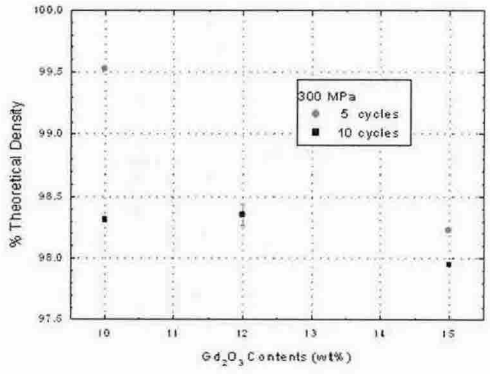

Figure 3. Sintered density vs. Gd content with different milling cycle.

2.3 Microstructure of (U, Gd)O_2 Sintered Pelletl

The grain size of (U, Gd)O_2 sintered pellet measures in the range of 6~8μm, and it decreases with increasing Gd content. And also it is observed that the amount of free Gd increased with increasing Gd content in the (U,

Gd)O2 sintered pellet. This is attributed to transcend the solubility limit above 10 wt% of Gd content.

3. Conclusion

Effects of milling cycles of CAM and compacting pressures on the high content Gd-bearing UO2 sintered pellet are investigated. Results are as following.

- Sintered density is not affected by milling cycles of above 5 cycles.
- Sintered density increases with increasing compacting pressure in the milling cycle of 5.
- The amount of free Gd increases with increasing Gd content in the UO2.
- The higher Gd content, the more amount of free Gd.
- the addition amount of poreformer on the sintered density and pore size distribution of UO_2-10wt%CeO_2 pellet is investigated. The results are as follows.
- The sintered density decreases linearly as the addition amount of poreformer increases. The slope is about –3.99

REFERENCES

[1] IAEA-TECDOC-844
[2] IAEA-TECDOC-544, February 1991

Acknowledgement

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