

Resintering Behavior of UO_2 -5wt% CeO_2 Pellets with Bimodal Pore Distribution

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1. Introduction

The dimensional behavior of UO_2 is an important parameter in irradiation performance. Irradiation-induced densification of sintered UO_2 pellet fuel has resulted in fuel column shortening and formed the gaps in the pellet fuel column. Afterwards, various investigations into the densification phenomenon are reported in the literatures[1-3]. This study was conducted to understand the effect of pore former on the density change and the resintering behavior of the pellets with bimodal pore distribution.

2. Methods and Results

UO_2 -5wt% CeO_2 powders were mixed by Turbula mixer for 1 hour and successively milled by dynamic ball mill for 2 hours. For density control, AZB($\text{C}_2\text{H}_4\text{N}_2\text{O}_2$) powders passed through the $212\mu\text{m}$ sieve, at concentrations of 0.3, 0.7, 1.0wt%, were mixed with the milled UO_2 -5wt% CeO_2 powder by Turbula mixer. Each powder was pressed with a compaction pressure of 3 ton/cm^2 and the sintering was conducted at 1700°C for 4 hours in H_2 atmosphere. All the sintered pellets were resintered at 1700°C or 1750°C for 24 hours in H_2 atmosphere. Densities were measured by the water immersion method.

The sintered or resintered density of UO_2 -5wt% CeO_2 pellets is plotted against the content of the AZB in Figure 1. The sintered density decreased linearly with the content of AZB as shown in Figure 1. The sintered density decreasing slope(B) is given by the following equation.

$$Y = A + BX \quad (1)$$

Y : sintered density of the AZB-mixed pellet

A : sintered density of the pellet AZB-free pellet

B(slope) : about -4

X : AZB content

Not only AZB-free pellets but also AZB-mixed pellets showed the density increase of more than 1%T.D. after resintering, indicating that both sintered pellets and resintered pellets have similar density slope on AZB content.

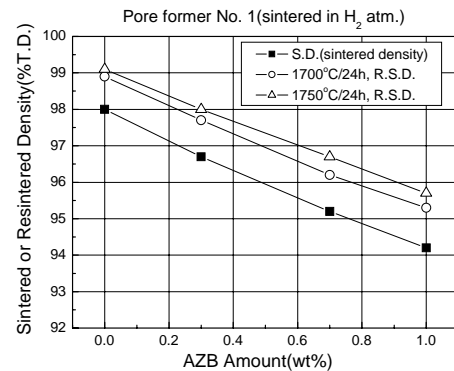


Figure 1. Dependence of sintered density or resintered density on AZB content.

In the case of the AZB-free sintered pellet, the volume fraction of each pore seems very low as shown in Figure 2 and that is typical UO_2 pore distribution. As the AZB content increases, the volume fraction of large pores, approximately $10\mu\text{m}$, remarkably increased. So, the porosity distribution of AZB-mixed pellets appears bimodal structure and consists of two well-defined peaks, one centered at about $2\mu\text{m}$ diameter which is due mainly to the sintering process and a second peak centered at about $10\mu\text{m}$ diameter which arises principally from the burning out of the AZB.

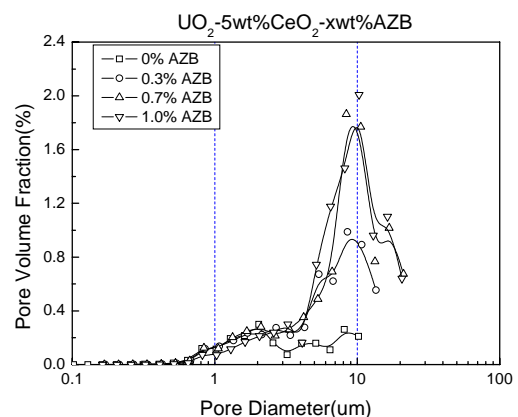


Figure 2. The variation of pore volume fraction as a function of AZB content in sintered pellets.

[4] G. Maier, H. Assmann and W. Dorr, Resinter Testing in Relation to In-pile Densification, J. Nucl. Mater. Vol.153, p. 213-220, 1988.

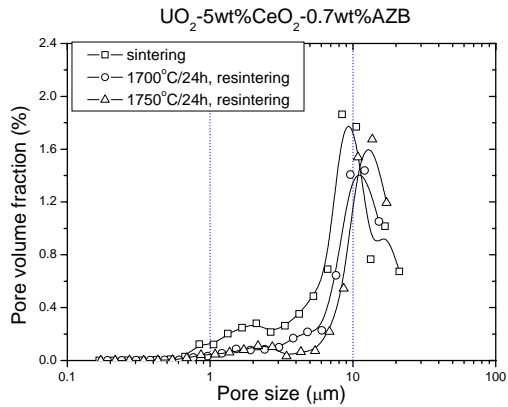


Figure 3. Pore volume fraction depending on resintering temperature in the $\text{UO}_2\text{-5wt\%CeO}_2\text{-0.7wt\%AZB}$.

Figure 3 shows the variation of pore volume fraction as a function of resintering temperature in $\text{UO}_2\text{-5wt\%CeO}_2\text{-0.7wt\%AZB}$ pellet which has bimodal pore structure. Coarse pores with the size of about $10\mu\text{m}$ as well as small pores below $3\mu\text{m}$ also seem to be shrunk after resintering. It is usually known that coarse pores are relatively stable at high temperature and so do not shrink easily after resintering[4]. That is, the pellets with the bimodal pore structure show the low density changes compared with the pellets with monomodal pore distribution after resintering. In our experiments, the grain sizes of resintered pellets increased by about 3 times compared with each sintered pellet. It is thought that large density increase of AZB-mixed pellets with bimodal pore structures is related to this large grain growth.

4. Conclusion

Sintered density decreased linearly with the AZB content and the slope of density change on the AZB content was about -4 . Not only the pellets with mono-modal pore distribution but also the pellets with bimodal pore showed the large densification during resintering. It is thought that the large densification of the pellet with bimodal pore is related to this large grain growth during resintering.

Acknowledgements

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