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Effect of Large Grained U_3O_8 Powder on Sintered Density of UO_2 Pellet

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1. Introduction

UO_2 pellet should have a proper density range to meet the design requirement for both densification and swelling[1]. Sintered density of UO_2 pellet without additive is too high to satisfy these conditions, so it should be adjusted using aid materials. There are several additives[2] which play a role as density depressant but U_3O_8 powder fabricated using scrap from UO_2 pellet and powder that do not meet the requirement are widely used in commercial process since it has benefit from the safety and economy's point of view. U_3O_8 powder is produced by oxidizing the scrap of UO_2 pellet and powder at the temperature around 450°C. Characteristics of U_3O_8 powder, especially particle size, vary with the raw material's properties and the oxidation conditions. In this study, U_3O_8 powders which have different particle size are fabricated using different procedures and their characteristics are examined. In order to investigate how much they affect the sintering density of UO_2 pellet, pellets have also been manufactured with the addition of different amount of those U_3O_8 powders and observed their properties.

2. Experimental Procedure

U_3O_8 powder (test powder) used in this study was fabricated by oxidizing large grained UO_2 pellet (grain size : 14.3 μm) at 400°C for 4 hrs with air at the flow rate of 150 cc/min. The large grained UO_2 pellet was manufactured at 1900°C for 6 hrs in a reducing atmosphere. U_3O_8 conventional powder used for comparison (conventional powder) was produced by oxidizing UO_2 pellet (grain size : 8.5 μm) at 450°C for 9 hrs. The manufactured U_3O_8 powders were added to UO_2 powder in the range of 4 to 12 wt%, respectively. The green pellets were fabricated using these powders in a double acting press and sintered at 1730°C for 4.4 hrs in a dry hydrogen atmosphere. Characteristics of the powder and properties of pellet such as surface area, particle size and sintered density were measured.

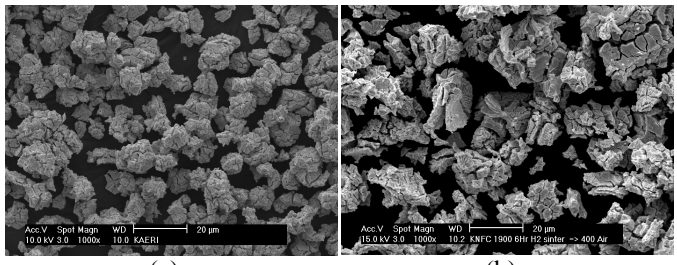
3. Results and Discussion

Table 1 shows the characteristics of two U_3O_8 powders and it can be clearly seen that the test powder fabricated from large grained UO_2 pellet has larger particle size than conventional powder produced from small grained UO_2 pellet. The average particle size of the test U_3O_8 powder is similar to the grain size of raw material as 14.25 μm but that of the conventional U_3O_8 powder is greater than the grain size of raw material.

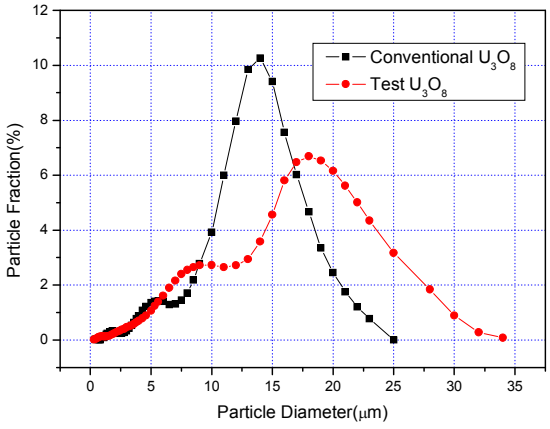
Table 1. Characteristics of U_3O_8 powder

	Specific Surface Area(m^2/g)	Average Particle Size(μm)
Conventional U_3O_8 powder	0.45	12.26
Test U_3O_8 powder	0.77	14.25

It is appeared that this is due to agglomeration of conventional U_3O_8 particle during oxidation. In general, the surface area is inversely proportional to the particle size but in this study, opposite result is obtained.



(a) (b)



(c)

Figure 1. Particle morphology and size distribution of U_3O_8 powder
(a) Conventional U_3O_8 (b) Test U_3O_8
(c) U_3O_8 particle size distribution

The test U_3O_8 powder with large particle size shows higher value of surface area than the conventional powder. It can be explained by the presence of many open cracks as can be seen in Fig. 1 (a) and (b). The density variation depending on kinds and amount of U_3O_8 powder is shown in Fig. 2. The density decrease is lower in the test powder added UO_2 pellet and its reduction rate is approximately 0.06 %T.D./wt% U_3O_8 powder. On the other hand, density is reduced about 0.09 %T.D. when 1 wt% of the conventional powder is added. As other manufacturing conditions are the same, this difference is appeared to be brought from the difference of the surface area of U_3O_8 powders that is directly related to sinterability.

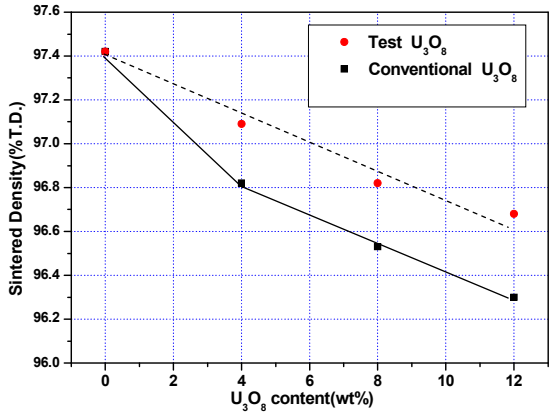


Figure 2. Effect of U_3O_8 powder on the sintering density of pellet

4. Conclusion

Characteristics of the U_3O_8 powder fabricated by executing the different procedure from the conventional method and properties of UO_2 pellet to which this powder was added were investigated. The particle size of the conventional U_3O_8 powder was larger than that of its raw material's grain size. Surface area of the test powder is greater than that of the conventional powder regardless of larger particle size. High surface area enhanced sinterability of the powder, resulting in lower density decrease.

REFERENCES

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