

Effects of Additives, Seed and Pore Former on the Shape and Size of Pores in UO Pellets



Abstract

The spatial size distribution and shape of the pores in doped-UO: pellets were analyzed. An optimal frequncy table was determined by grouping and counting the equivalent diameter and the shape factor of pores collected from polished pellet specimen, and then the frequency was converted to spatial distribution of spherical particles. The size of pores in Nb₂O₅ - and TiO₂ -doped AUC-UO: pellets was 1.4 to 2.4 times larger than that of normal AUC-UO: pellet. The fraction of round pores was found to increase in 0.1 wt% TiO₂ -doped AUC-UO: pellet. The size of pores was not largely changed and the fraction of pores with shape factor 0.5 to 0.7 decreased when seed was doped to ADU-UO: powder. Pores formed by addition of pore former to ADU-UO: pellet were stable but not round.

1.

				UO_2					
			[1].	UO_2			가 (Nb	02O5, TiO2)
UO_2						[2],	(seed)	가	
					[3].	가	가		
가	가	가							
2.									

				Table 1	l			Nb2O5フト	가	AUC-	$-UO_2$		$CO_2/H_2 =$
0.01		1700	4			,					1	700	4
	. 4 wt	%	(seed)	0.35 w	vt %			(AZB)가	가	ADU	$-UO_2$		
	1700	24						95.29	%		98.1%		
		Table	1								Ima	ige-Pro	Plus (Media
Cybern	netics, U	SA)								5	9		
	가 5	00											
가	(equiv	valent dia	amet er)										
	<i>d</i> =	$\sqrt{4A}$ /	$\overline{\pi}$,									(1)	
	d	가 , /	A										
						sha	ipe f	act or [4]					
	Shap	e factor	0 1				, 1				0	가	

. Image-Pro Plus 가

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$$\Delta = \frac{(\log d)_{\max} - (\log d)_{\min}}{n - 1}, \qquad (2)$$

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3

$$(A_{A})_{j} = 100 \cdot \pi \frac{d_{j}^{2}}{4} \cdot (N_{A})_{j} [\%], \qquad (3)$$

$$j \qquad , A_{A} \qquad , N_{A} \qquad .$$

$$7 \downarrow \qquad , \qquad (3)$$

가

$$(N_{V})_{j} = \frac{(N_{A})_{j} - \sum_{i=j+1}^{n} P_{j,i} D_{i} (N_{V})_{i}}{P_{j,j} D_{j}}, \qquad (4)$$

$$N_{V} , j , n, n-1, n-2,..., 2, 1 , D_{i}$$

[6].

[5].

$$P_{i,j} = \sqrt{1 - (D_{i-1}/D_j)^2} - \sqrt{1 - (D_i/D_j)^2}, i j .$$
(5)
7

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(V_v)

$$(V_{\nu})_{j} = 100 \cdot \frac{4}{3} \pi \left(\frac{D_{j}}{2}\right)^{3} \cdot (N_{\nu})_{j} \ [\%].$$
 (6)

3.

. AUC-UO₂ (flake-like) [7] 1 2 , Nb₂O₅ TiO₂가 가 . 가 가 가 , . ADU-UO₂ U_3O_8 가 가 가 , . 3 AUC-UO₂ . UO_2 (mode) 3.7 µm . 0.3 wt% , 5.1 18.2 µm Nb₂O₅7 가 UO2 . 0.1 $0.2 \ wt \ \% \qquad TiO_2 \ 7 \ UO_2$, 6.0 9.1 μm . , 1 가 AUC-UO₂ 가 가 가 . ADU-UO₂ 4 ADU-UO₂ • 가 가 2.1 μm . 4 wt% , 2.2 μm ADU-UO₂ . 4 wt % 0.35 wt % 7 가 1.8 10.2 µm . , ADU-UO₂ 가 가 가 8.2 µm . . ADU-UO₂ 가 2 µm . . Shape factor 가 0.2 0.4 5 AUC-UO₂ shape factor 가 . TiO₂ 0.1 가 가 0.2 wt % 가 wt % AUC-UO₂ . Shape factor 가 0.5 0.7 . 0.1 wt% TiO₂ 가 0.1 wt% 가 TiO₂ ADU-UO₂ . 6 ADU-UO₂ shape factor 가 . 4 wt% shape factor $7 \downarrow 0.5 0.7$ 가 . ADU-UO₂ ,

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4.

 Nb2Os, TiO27
 7
 AUC-UO2
 7
 7
 ADC-UO2

 shape factor
 .
 AUC-UO2
 3.7 µm, 0.3 wt %

Nb₂O₅7ŀ	가	5.1	18.2 µm, 0.1	0.2 wt%	TiO₂フト	가	6.0	9.1
μm .	ADU-UO ₂		4 wt %	가			,	
가				,			. AUC-UO ₂	
0.1 wt	t% TiO2가 가						ADU-UO ₂	4
wt %	0.35 wt%		가 가					. 4
wt %	가		shape factorフ	0.5 0.7				

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[3]	, "U ₃ O ₈	UO ₂	," '99
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Pellet	Sintered Conditions	Theoretical Density [%]		
AUC-UO ₂	H ₂ , 1700 , 4h	95.2		
AUC-UO ₂ + 0.3 wt % Nb ₂ O ₅	$CO_2/H_2=0.01, 1700$, 4h	96.7		
AUC-UO ₂ + 0.1 wt % TiO ₂	H ₂ , 1700 , 4h	97.8		
AUC-UO ₂ + 0.2 wt % TiO ₂	H ₂ , 1700 , 4h	98.1		
ADU-UO ₂	H ₂ , 1700 , 4h	97.5		
ADU-UO ₂ + 4 wt % seed	H ₂ , 1700 , 4h	97.1		
ADU-UO ₂ + 4 wt % seed + 0.35 wt % AZB	H ₂ , 1700 , 4h	95.8		
$ADU-UO_2 + 4 wt\%$ seed				
+ 0.35 wt% AZB	H ₂ , 1700 , 24h	96.2		
(Resintered)				

Table 1. UO₂ pelltes for measuring the size and structure of pores



(a) AUC UO₂

(b) AUC $UO_2 + 0.3 \text{ wt \% } Nb_2O_3$



- (c) AUC UO₂ + 0.1 wt % TiO_2
- (c) AUC UO₂ + 0.2 wt % TiO₂

Fig. 1. Pores in doped AUC-UO₂ pellets.



(a) ADU UO₂

(b) ADU $UO_2 + 4$ wt % seed



(b) ADU UO₂ + 4 wt % seed + 0.35 wt % AZB

(d) ADU UO₂ + 4 wt % seed + 0.35 wt % AZB (Resintered)

Fig. 2. Pores in doped ADU-UO₂ pellets.



Fig. 3. Spatial ditribution of pore size in doped AUC-UO₂ pellets.



Fig. 4. Spatial ditribution of pore size in doped ADU-UO2 pellets.



Fig. 5. Variation in the number of pores with shape factor in doped AUC-UO₂ pellets.



Fig. 6. Variation in the number of pores with shape factor in doped ADU-UO₂ pellets.