

Si₃N₄

A Study on Continuous Casting of Uranium Metal using Si₃N₄ Mold

, , , , , ,

150

, , 13.5 mm

.
Si₃N₄, 2.5

m

Abstract

An advanced storage technology for spent nuclear fuel was suggested by the Korea Atomic Energy Research Institute, which is that the metallic uranium is made from oxide spent fuel reduced by lithium and fabricated as a rod-type with diameter 13.5 mm and stored in a canister. In order to fabricate the rod-type metallic uranium, continuous casting technique has been applied. Through experiments for various casting conditions, we succeeded to get a 2.5m length and 13.5 mm diameter Uranium rod using Si₃N₄ mold which was designed to have a proper mold temperature gradient.

1.

LiCl Li

1/4

¹³⁷Cs, ⁹⁰Sr

1/2

. [1]

[2], 가

가

, 가 ,

가

[3, 4]

BN

1.3m

SN

2.5m

, 가

2.

가 Fig. 1

2-1.

가

ZrO₂, Y₂O₃, SiO₂

Holcote#110

가

R.P, B.P, D.P

가 10⁻⁴ torr

가 3kHz

가 300

10 kW

20 kW

가

1 Ar

가 (99.9%)

. Ar 가

. High-Low

10

2-2.

servo motor

Ar 가

가

2 Ar 가

가 , 가
 step 가 (-) . 2

3.

3-1.

, BN , Si₃N₄
 Table 1 . ,
 13.7mm 14.3 , BN Plug
 . BN ,
 BN 15mm BN plug,
 140mm BN graphite 가 180mm
 . Si₃N₄ ,
 BN 가

Table 1. The experimental condition of uranium continuous casting using Si₃N₄ mold

						BN			Si ₃ N ₄		
	DU (g)	6282.0	5219.5	6743.3	6727.8	5545.8	6453.5	5381.9	5433.6	6544.9	6972.3
	(/min)	22.5	22.6	23.1	22.5	22.5	23.1	23.7	26	22.5	25.4
	(× 10 ⁻⁴ torr)	9.8	1.9	0.96	0.96	1.9	1.2	2.1	1.9	0.81	5.4
()		1286	1271	1248	1300	1295	1294	1246	1357	1360	1343
	가	1258	1164	1166	1211	1201	1188	1158	1196	1201	1205
	1	1098	1009	1031	1080	1056	1084	1046	1075	1079	1026
	2	798	715	696	735	699	689	709	738	732	711
	(mm)	2	1	1	1	1	1	1	1	1	-
	(sec)	2	3	3	5	2	2	3	2	2	-
	(mm/sec)	65	20	20	12	25	25	20	25	25	-
가	1 가 (lpm)	30	30	30	30	30	30	30	30	30	30
	2 가 (lpm)	5	-	5	-	5	5	5	5	5	10

3-2.

1248 1300 , 12 mm/min 65 mm/min
 . 100mm ,

(Fig. 2). , , 30mm 50mm
 65 mm , 가
 가 가 가
 (Fig. 3),
 가 (Fig. 4).

3-3. BN

, , 840mm, 580mm, 800mm
 (Fig. 5). 300mm 가
 가
 34%, 22%, 31%

3-2. , 가

가 BN
 가 가
 가
 65mm BN
 , Si₃N₄
 Fig. 6

3-4. Si₃N₄

1920mm ,
 가 BN 가
 2200mm 가
 , 2300mm
 Fig. 7 가 25mm/min

45mm/min, 65mm/min, 80mm/min

500mm

25mm/min, 35mm/min,
2.5m

4.

가 , BN

300mm

가

가

Si_3N_4

25mm/min ~ 80mm/min

2.5m

Si_3N_4 가

[1] , “ 가

”, KAERI-NEMAC/AR-19/94,

, 1994.

[2]

,”

”

99

[3]

“

” 1998

[4]

“

” 2000

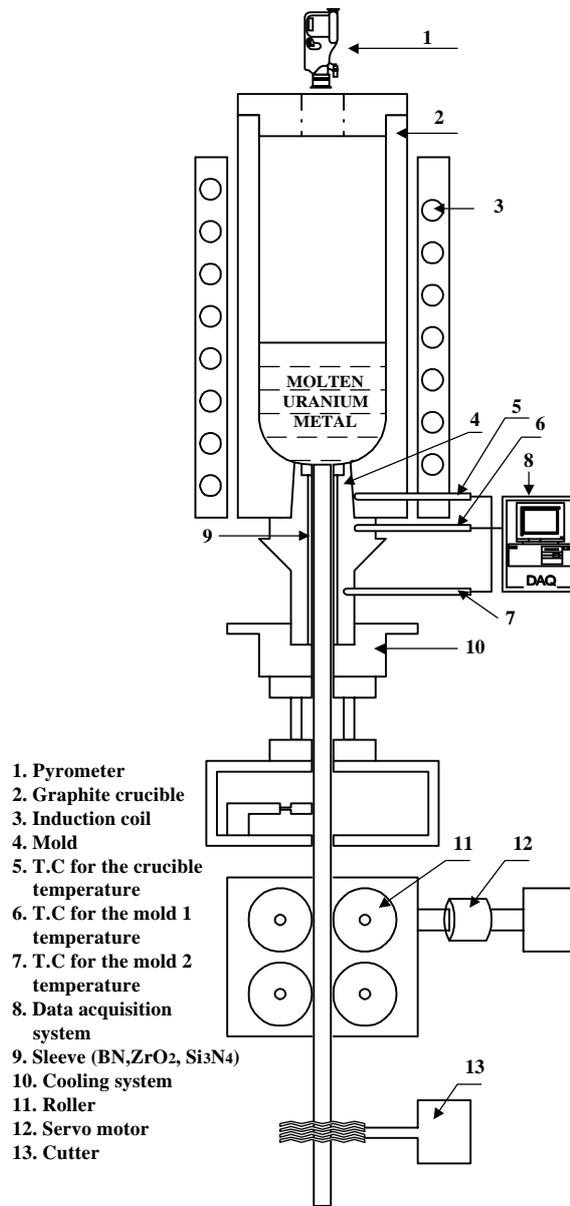


Fig 1. Schematic diagram of the uranium continuous casting apparatus



Fig. 2. Photograph of continuous casting uranium bar at condition.



Fig. 3. In case of using zirconia mold, Break-out part.



Fig. 4. Broken zirconia sleeve by thermal expansion.

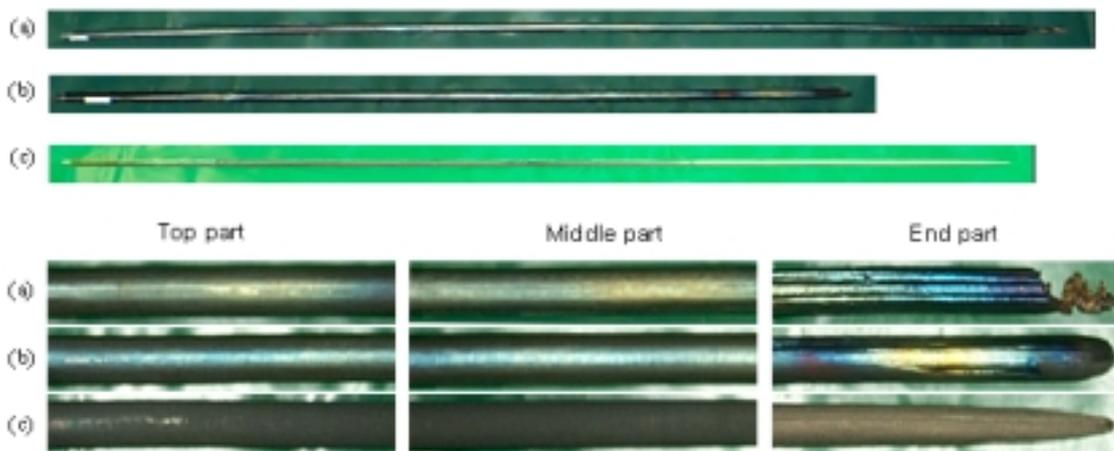
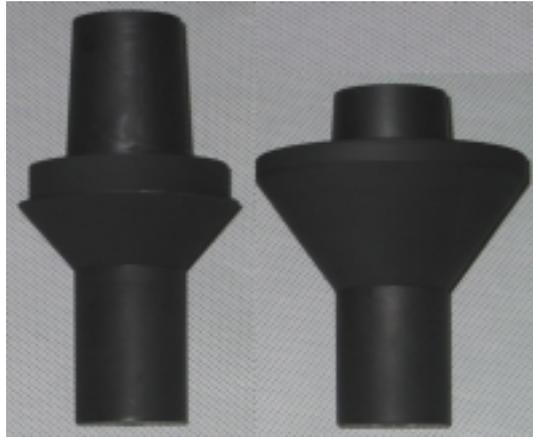


Fig. 5. In case of using BN mold, Photograph of continuous casting uranium bar at
 (a) condition, (b) condition, (c) condition



(a)

(b)

Fig. 6. Photograph of (a) before and (b) after changing mold design.

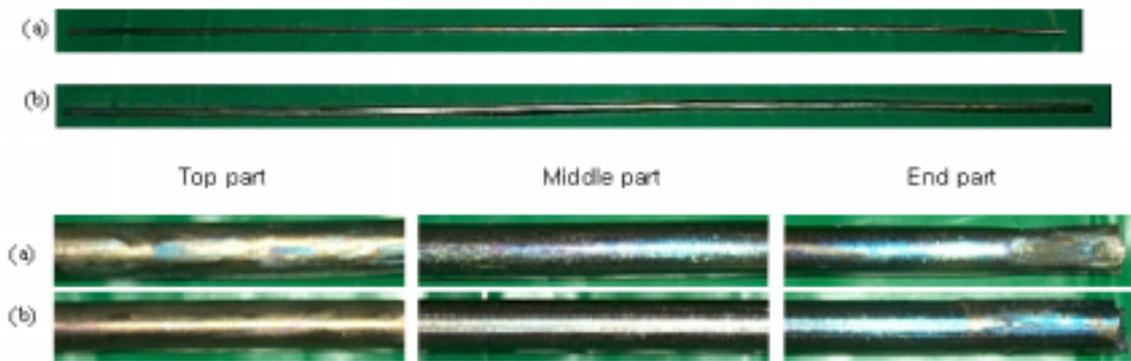


Fig. 7. In case of using Si_3N_4 mold, Photograph of continuous casting uranium bar at

(a) condition, (b) condition.