

'2000

Hot Cell Examination on the Irradiated Fractured Control rod Guide Tube Split Pin of Pressurized Water Reactor

150

1 (water room)

(IMEF)

2

1

100 mSv/h

SEM

(Inconel)

(PWSCC : Primary Water

750-X
Stress-Corrosion Cracking)

(database)

Abstract

The fractured control rod guide tube split pins of pressurized water reactor were examined to investigate the fracture mechanism and kind of material by non-destructive and destructive tests in the hot cell of IMEF (Irradiated Materials Examination Facility). The test pieces are two(2) fractured pins and one(1) non-fractured pin and the maximum dose equivalent is 100 mSv/h. The hot cell examination was achieved through 2 months including specimens transportation to hot cell facility, visual inspection, SEM observation on the fracture surface, chemical analysis by EPMA, metallography, and hardness test. The kind of irradiated material was known to Inconel 750-X and the fracture mechanism was assumed by PWSCC due to primary coolant. The data bank of this kind of irradiated material was established as well as the test procedure was obtained through hot cell examination.

1.

1 (water room)
100 mSv/h

1 [1,2,3,4] 2
SEM 2

2.

2.1

(type - A)

(steel wire)

가

가

가

3

M1

3

(tray)

- A : Shank - shoulder 가
- B : Shank portion
- C :

2.2

1) - A : Shank - shoulder 가 42.5 mm
100 mSv/h() 2
M2

3 rpm
2) - B : Shank portion 80 mm
23 mSv/h() 3
M2

3 rpm

3 mm

가

가

2.3 (SEM)
 M3 (micro-cutting machine) - A - B
 4 inch 0.5
 inch

1) - A : 28.6 mm 2 mm
 8

2) - B : 15.6 mm 2 mm
 가 2 mm

3) M3 M7 20
 (image) 10

image-pro 5 6
 4) (SEM) 5
 (Ag) (paint)
 (intergranular fracture)

(dimple) 2000 2

- A (Shank - shoulder) 5
 shoulder 가

7 X-750 (EPMA)
 가 (crud)

8

shank shoulder 9
 X-750

-B () 6 가

10

X-750

shank

11

(intergranular fracture)

가

가

12

2000

2.4

-A

(leaf spring)

-C

M3

(mounting)

SiC

(#320, #600)

(6 μ, 1 μ)

M5a

silver paint

가

가

15.0kV, 30nA

X-750

Mn, Cu, Cr, Fe, Ni, Co, Mo, Ti, Al, Si

LIF

PET

(calibration)

200 μm

19

(beam)

10

10 μm

13

X-750

[5]

2.5

95 Mℓ +

5 Mℓ)

10

3.0 V,

10 가 가

(

80 Mℓ +

20 Mℓ)

10

3.0 V,

10 가 가

-A

-C

X-750

-A

-C

14

15

X-750

X-750

X-750
-A

2 X-750

(PWSCC : Primary Water Stress- Corrosion Cracking)

2.5

-A

-C

MICRO-DUROMAT 4000E

가

100 g 10 g/sec ,

1 mm

5

542 ± 29 HV

510 ± 19 HV (

95%)

750-X ^[6]

3.

(SEM)

(core)

(EPMA)

750

750

가

가 50 mm

, 30 mm

M3

가 50 mm

, 30 mm

가

4.

1.

1 , “

1

”, KAERI/TR

- 1301/99, , 1999.

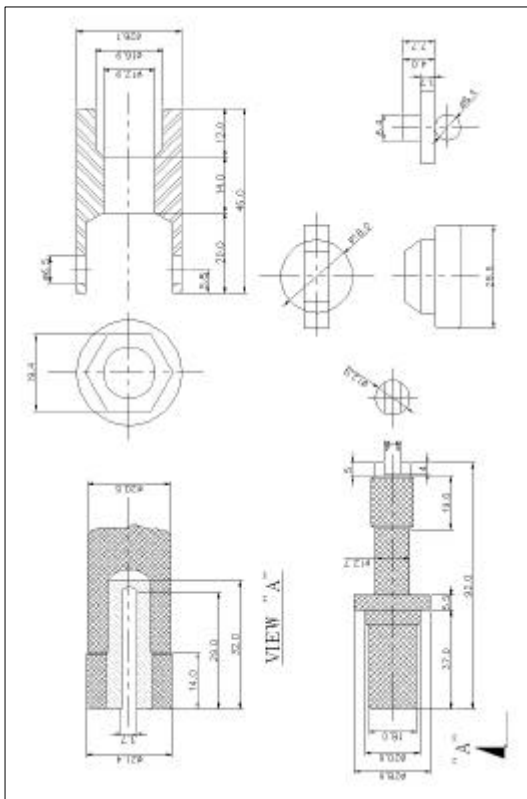
2. 4 , “ ”, KAERI/TR-1078/98, , 1998.

3. 4 , “ ”, KAERI/TR-944/98, , 1998.

4. , “EPMA Zircaloy-4 ”, , 1994.

5. “ ”, HFMS-4, , 1995.

6. ASTM B637-93a, “Standard Specification for Precipitation-Hardening Nickel Alloy Bars, Forgings, and Forging Stock for High-Temperature Service”, ASTM(1998).



1.

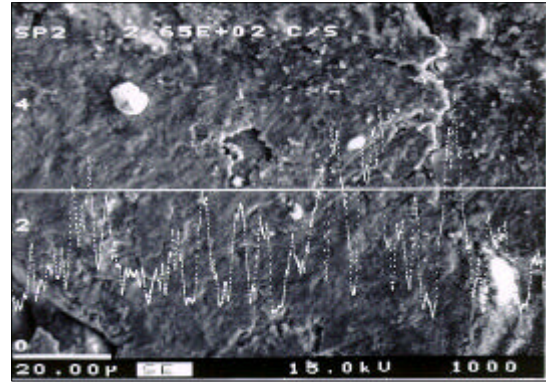


2. -B ().

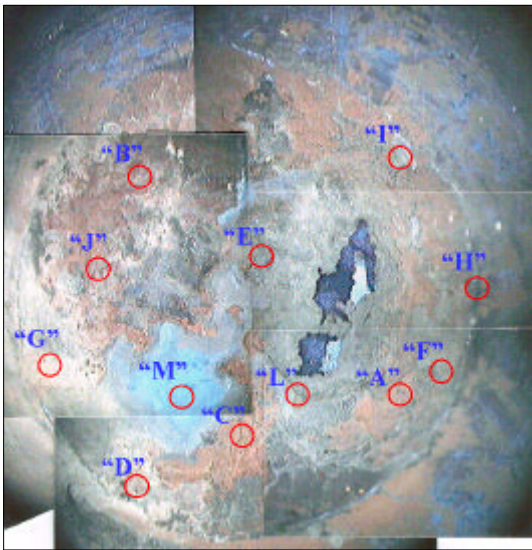
3. -A ().



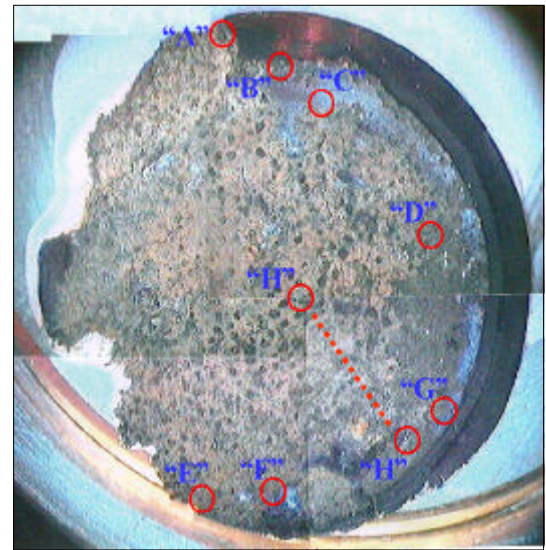
3. -C .



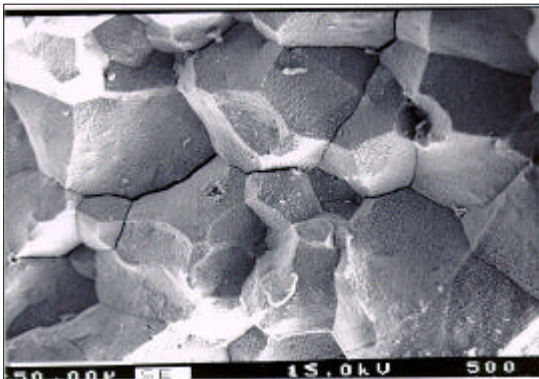
7. -A "C"
(O) trace.



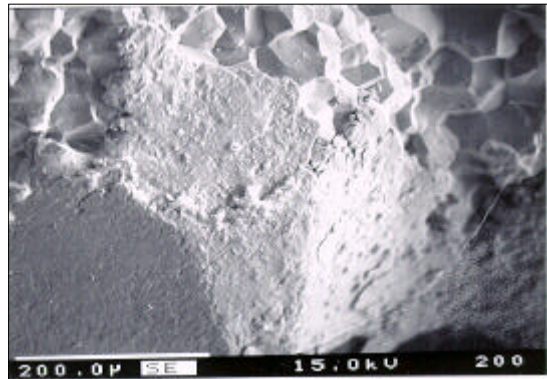
5. -A



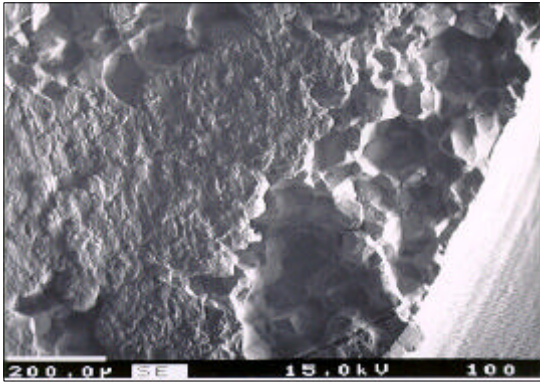
6. -B



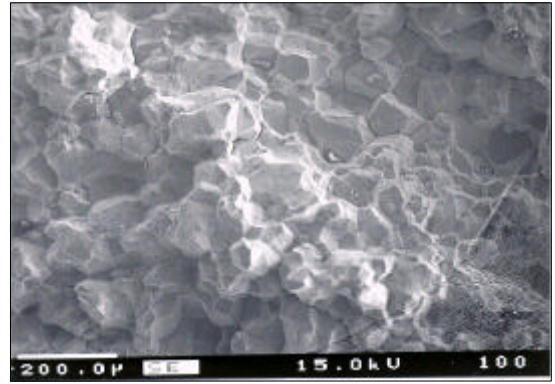
8. -A "A"



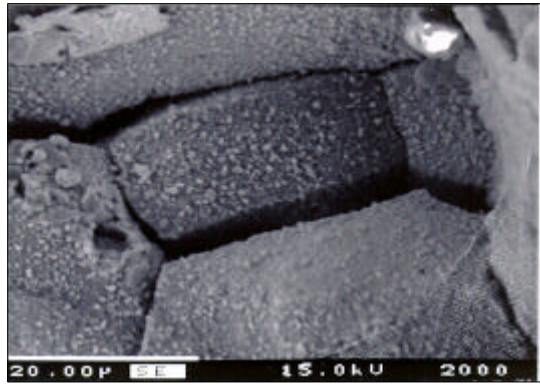
9. -A "E"



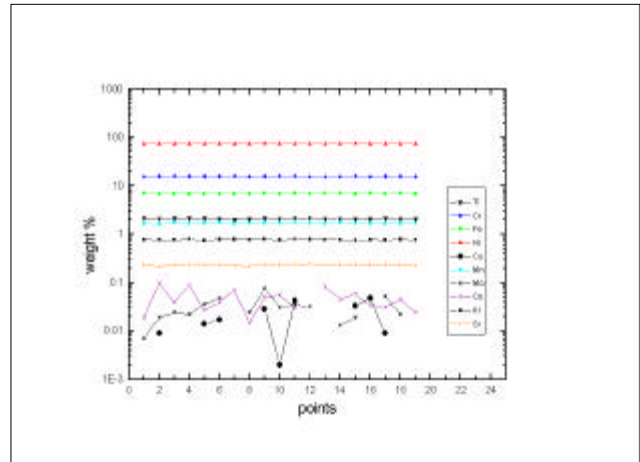
10. -B "H"



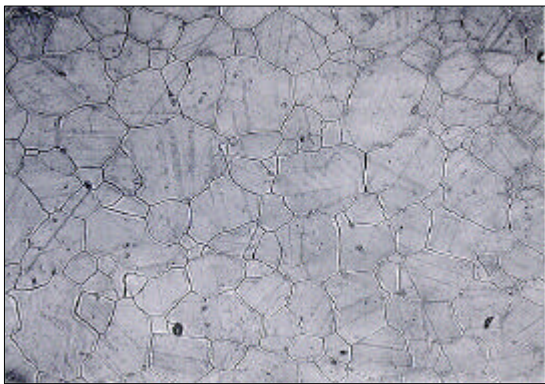
11. -B "H"



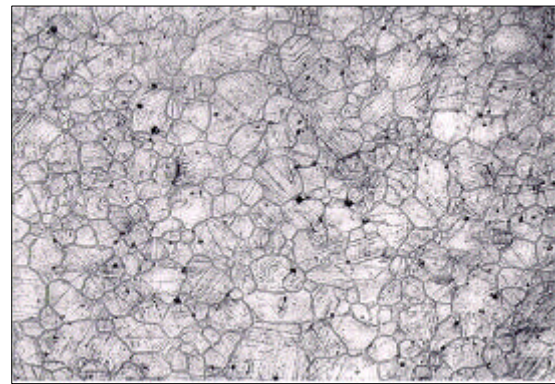
12. -B "H"



13. point



14. -A (x200).



15. -B (x100).