

STATUS OF U.S./JAPAN COLLABORATIVE PROGRAM PHASE II HFIR TARGET AND RB CAPSULES – J. E. Pawel, K. E. Lenox (Oak Ridge National Laboratory) and I. Ioka (Japan Atomic Energy Research Institute)

OBJECTIVE

The objective of the High Flux Isotope Reactor (HFIR) irradiations is to determine the response of various U.S. and Japanese austenitic and ferritic steels with different pretreatments and alloy compositions to the combined effects of displacement damage and helium generation. Specimen temperatures during irradiation range from 60 to 600°C and fluences range up to 60 dpa. The RB experiments are a continuation of the ORR spectrally tailored experiments in which the spectrum is modified with a hafnium shield to simulate the expected fusion helium to damage (He/dpa) ratio. In the HFIR target capsules, many specimens have been isotopically tailored in order to achieve fusion helium generation rates.

SUMMARY

Capsules HFIR-MFE-JP9 through JP16 operated in the HFIR target region and accumulated doses of 18, 34, and 57 dpa at temperatures of 300, 400, 500, and 600°C; all eight capsules in this series have been irradiated and disassembled. Capsules JP20, 21 and 22 were designed to accumulate 8, 18, and 34 dpa, respectively, with specimen temperatures of 300-600°C. JP20 and JP21 have been removed from the reactor; JP22 has accumulated 18.6 dpa as of the end of this reporting period. HFIR-MFE-200J-1 and 400J-1 capsules achieved the goal of 20 HFIR irradiation cycles, or approximately 9 dpa, and were removed from the reactor to the cooling pool. Disassembly is scheduled for the next reporting period.

PROGRESS AND STATUS

Target Capsules JP9 through JP16

Capsules HFIR-MFE-JP9 through JP16 operated in the HFIR target region and accumulated doses of 18, 34, and 57 dpa at temperatures of 300, 400, 500, and 600°C. All eight capsules in this series have been irradiated and disassembled. Specimen testing, including densitometry and tensile testing, is complete on the specimens from JP10, 11, 13, 14, and 16. Transmission electron microscopy examination is in progress. Specimen testing from JP9, 12, and 15 will be conducted over the next 18 months. Complete descriptions of the design, construction, installation, operation, and specimen matrix can be found in previous reports [1-4].

Target Capsules JP20 through 22

Capsules JP20, 21 and 22 were designed to accumulate 8, 18, and 34 dpa, respectively, with specimen temperatures of 300-600°C. JP20 has been removed from the reactor and disassembled. JP21 completed the scheduled 11-cycle irradiation during this reporting period (end of cycle 334) and was removed from the reactor to the cooling pool. It achieved an approximate peak dose of 18.6 dpa. JP22 is scheduled to be irradiated for 21 cycles, to an approximate peak dose of 34 dpa. As of the end of cycle 334 (April 9, 1995) this capsule had accumulated 21337 MWd, or approximately 18.6 dpa. Details of the operation of these capsules are shown in Table 1 and described elsewhere [5-6].

RB Capsules HFIR-MFE-60J-1, 200J-1, 330J-1 and 400J-1

The design and operation of the four RB capsules have been previously described [7-12]. During this reporting period, the 200J-1 and 400J-1 capsules achieved the goal of 20 HFIR irradiation cycles, or approximately 9 dpa, and were removed from the reactor. This is in addition to the 7 dpa accumulated during the Oak Ridge Research Reactor (ORR) irradiation, bringing the total for the two-stage irradiation

to 16 dpa. Dosimetry and helium measurements from specimens from the 60J-1 and 330J-1 capsules indicate that this experiment was successful in producing fusion relevant helium/dpa levels (approximately 11 appm He/dpa) [13]. Details of the operation of these capsules are shown in Table 2. These capsules are scheduled to be disassembled during the next reporting period.

Table 1. Irradiation History of HFIR Target Capsules JP20, 21, and 22.

Cycle No.	HFIR Operation			JP20 [†] , 21 [‡] , 22	
	Start Date	End Date	MWd/Cycle	MWd	dpa*
322	12/16/93	1/7/94	1854	1854	1.62
323	1/23/94	2/14/94	1874	3728	3.25
324	3/5/94	4/1/94	1907	5635	4.92
325	4/10/94	5/3/94	1907	7542	6.58
326	5/8/94	6/3/94	1825	9367	8.18
327	6/26/94	7/18/94	1903	REMOVED FOR 2 CYCLES	
328	7/31/94	8/21/94	1922		
329	8/27/94	9/16/94	1513**	10880	9.50
330	10/11/94	11/3/94	1950	12830	11.21
331	11/12/94	12/7/94	1994	14824	12.94
332	12/18/94	1/11/95	2008	16832	14.69
333	1/31/95	2/27/95	2317	19149	16.72
334	3/14/95	4/9/95	2188	21337	18.63

[†]JP-20 removed at End of Cycle 326

[‡]JP21 removed at End of Cycle 334

* dpa levels based on 0.000873 dpa/MWd in the target capsules

** Due to power variations over this cycle, this number is not exact

REFERENCES

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2. R. L. Senn, "Status of U.S./Japan Collaborative Program Phase II HFIR Target Capsules," Fusion Reactor Materials Semiannual Progress Report for the Period Ending March 31, 1988, DOE/ER-0313/4, U.S. DOE Office of Fusion Energy, 1988, p. 7.
3. R. L. Senn, "Status of U.S./Japan Collaborative Program Phase II HFIR Target Capsules," Fusion Reactor Materials Semiannual Progress Report for the Period Ending September 30, 1988, DOE/ER-0313/5, U.S. DOE Office of Fusion Energy, 1989, p. 6.
4. J. E. Pawel, K. E. Lenox, A. W. Longest, R. L. Senn and K. Shiba, "Status of U.S./Japan Collaborative Program Phase II HFIR Target Capsules," Fusion Reactor Materials Semiannual Progress Report for the Period Ending September 30, 1994, DOE/ER-0313/17, U.S. DOE Office of Fusion Energy, 1995, p. 3.
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Table 2. Irradiation History of HFIR-MFE-200J-1 and 400J-1.

Cycle No.	HFIR Operation			200J-1 and 400J-1	
	Start Date	End Date	MWd/Cycle	MWd	dpa*
313	11/21/92	12/15/92	1858	1858	0.46
314	12/20/92	1/12/93	1867	3725	0.91
315	1/19/93	2/11/93	1861	5586	1.37
316	2/17/93	4/3/93	1807	7393	1.81
317	4/23/93	5/14/93	1841	9234	2.26
318	5/20/93	6/13/93	1878	11112	2.72
319	6/18/93	7/10/93	1863	12975	3.18
320	7/15/93	8/7/93	1934	14909	3.65
321	8/12/93	9/4/93	1884	16793	4.11
322	12/16/93	1/7/94	1854	18647	4.57
323	1/23/94	2/14/94	1874	20521	5.03
324	3/5/94	4/1/94	1907	22428	5.49
325	4/10/94	5/3/94	1907	24335	5.96
326	5/8/94	6/3/94	1825	26160	6.41
327	6/26/94	7/18/94	1903	28063	6.88
328	7/31/94	8/21/94	1922	29985	7.35
329	8/27/94	9/16/94	1513**	31498	7.72
330	10/11/94	11/3/94	1950	33448	8.19
331	11/12/94	12/7/94	1994	35442	8.68
332	12/18/94	1/11/95	2008	37450	9.18

* dpa levels based on 0.000245 dpa/MWd

** Due to power variations over this cycle, this number is not exact

6. J. E. Pawel, A. W. Longest, R. L. Senn, K. Shiba, D. W. Heatherly and R. G. Sitterson, "Status of U.S./Japan Collaborative Program Phase II HFIR Target and RB* Capsules," Fusion Reactor Materials Semiannual Progress Report for the Period Ending September 30, 1993, DOE/ER-0313/15, U.S. DOE Office of Fusion Energy, 1994, p. 3.
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13. L. R. Greenwood, C. A. Baldwin and B. M. Oliver, "Neutron Dosimetry, Damage Calculations, and Helium Measurements for the HFIR-MFE-60J-1 and MFE-330J-1 Spectral Tailoring Experiments," Fusion Reactor Materials Semiannual Progress Report for the Period Ending September 30, 1994, DOE/ER-0313/17, U.S. DOE Office of Fusion Energy, 1995, p. 28.