Material Irradiation Testing Schedule after Reoperation of HANARO

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1. Introduction

The High Flux Advanced Neutron Application Reactor (HANARO) has been operating as a platform for basic nuclear research in Korea, and the functions of its systems have been improved continuously since its first criticality in February 1995 [1]. Various neutron irradiation facilities such as rabbit irradiation facilities, loop facilities, and the capsule irradiation facilities for irradiation tests of nuclear materials and fuels have been developed at HANARO [2,3]. A lot of specimens have been irradiated at dedicated vertical holes of CT, IR, OR, and IP according to user testing requirements. The vertical test holes have also been used for radioisotope production.

After the Fukushima nuclear accident in Japan, Special Safety Inspections by the Nuclear Safety and Security Commission (NSSC) on HANARO was conducted. Some part of the reactor building did not meet the seismic performance assessment standard of a magnitude 6.5 on the Richter scale (ground acceleration of 0.2 g). HANARO has been temporarily shut down for a safety reinforcement construction and it will be completed by February 2017. Reoperation of the reactor will be determined after a safety assessment by the NSSC.

During the reactor stop, lots of user requests for neutron irradiation testing have been piled and a schedule of material testing after the reoperation of the reactor was determined at HANARO.

In this paper, the status of material irradiation testing requested by users and the determined irradiation testing schedule after reoperation of the reactor are described.

2. User Requests for Irradiation Testing

As the reactor doesn't operate for more than two years, lots irradiation testing requested from various users have been piled. Table I shows a list of material irradiation testing requested from HANARO users up to February this year. As the irradiation technology of HANARO was basically developed for irradiation testing under a commercial reactor operation environment, there are limitations on irradiation temperature and fluence. Table II summarizes the current status of irradiation technology at HANARO compared with the advanced foreign technology. To scope the user requirements for a higher neutron irradiation temperature and fluence, several efforts using an instrumented capsule have been performed at HANARO [4,5].

Due to the limited test holes in the core of HANARO (CT, IR, OR, IP), there are currently two or three users waiting for neutron irradiation testing per each test hole. Based on importance and urgency of the user irradiation testing, an irradiation testing schedule at HANARO was determined, as shown in Fig. 1. Although the IP test holes (having low neutron flux and temperature limit) are available for irradiation testing after reactor reoperation, the CT/OR test holes in the reactor core were already scheduled for more than 3 years after reactor reoperation.

Table I: Neutron irradiation tests requested by users at HANARO (Feb. 2017)

Materials	Irradiation Temp.(℃)	Rx. Cycle (dpa)	User
Fusion ARAA	300~350	>8 (>5)	KAERI
ARAA Welds	320	8~15 (5-10)	KAERI
AR Cladding	300	4~6	KAERI
PWR Cladding	350~400	2~4	University
VHTR Core	300~1000	8~24 (5~15)	KAERI
Long Life SPND	300	8~24	KHNP
U-Mo Fuel		8	KAERI
SiC Epoxy	~200	8	KAERI
Fission Mo		1	KAERI
Th-based Fuel		8~24	KAERI
SiC Composite	900~1600	8	KAERI
SFR ODS steel	300～500	>8 (>5 dpa)	KAERI
Low Alloy RPV	300	2	KAERI
Fuel Cladding	RT	33 (17 dpa)	KAERI
U-Mo Fuel		>16	KAERI-ANL
VHTR Fuel	800~1300	~40	KAERI-JAEA

ARAA: Advanced Reduced Activation Alloy, SPND: Self-Powered Neutron Detector, AR: Accident-Resistant, ODS: Oxide Dispersion Strengthened

Table II: Status of irradiation technology of HANARO

Irradiation	KAERI	Worldwide	R&D Target
Temp. (℃)	30～700	30～1000	30～1000

Cycle (days) Fluence (n/cm^2,(dpa))	8 (~200) 1.9x10^{21} (3.0)	No limit	15 (~375) 4.0x10^{21} (5.0)

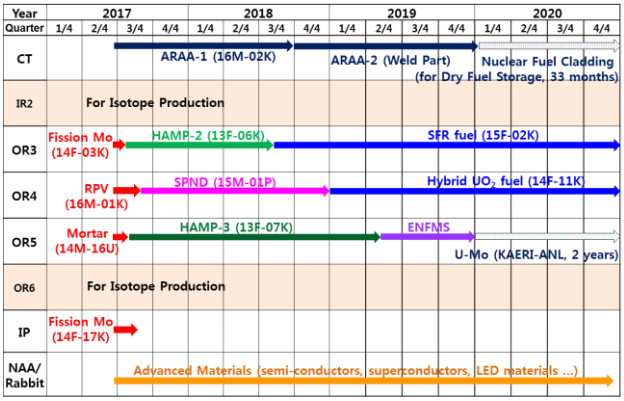

Fig. 1. Irradiation testing schedule after reoperation of HANARO

According to the irradiation testing schedule, irradiation capsules were already designed, fabricated (as shown in Fig. 2), and safety-analyzed. They will be installed and irradiated at each dedicated test hole after reoperation of HANARO.

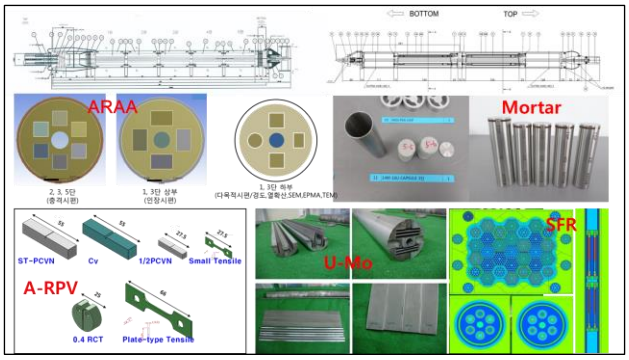

Fig. 2. Various irradiation capsule and specimens that will be irradiated at HANARO

3. Possibility for New User of Irradiation Testing

To scope the increased user necessity for neutron irradiation testing, two possibilities have been considered at HANARO. The first way is a removal of the FTL system that doesn't work at these days. The related system (Fig. 3) is being planned to be removed at the end of this year. Therefore, the IR1 test hole of the reactor allocated for the FTL system might be available for material irradiation from next year and should be planned for new users. Another possibility is a construction of the Ki-Jang Research Reactor (KJTR). After a start-up of the new reactor, HANARO will specialize more on the irradiation research of nuclear materials. However, the construction schedule of KJRR that was planned to start up in 2019 seems to be delayed.

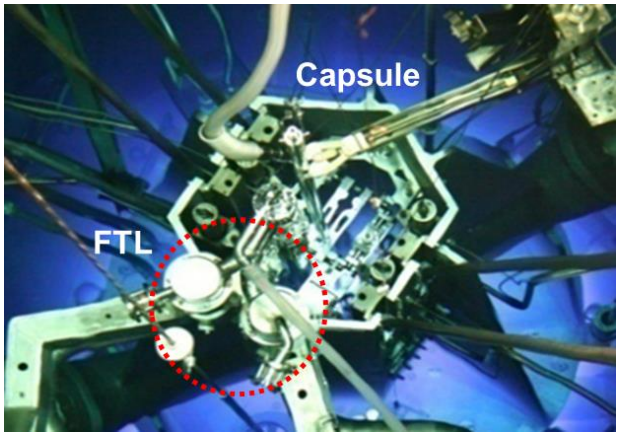

Fig. 3. Reactor core and material irradiation facilities (Capsule and FTL)

4. Summary

HANARO is temporarily shut down for a safety reinforcement construction and it will be completed by March 2017. Reoperation of the reactor will be determined after a safety assessment by the NSSC (Nuclear Safety and Security Commission). The CT/OR test holes of the reactor are already scheduled for material irradiation testing for more than three years after reactor reoperation. The IP test holes (having low neutron flux and temperature limit) are available for material irradiation testing after reactor reoperation. The IR1 test hole may be available for material irradiation testing from next year and a utilization schedule is being planned for new users.

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