§48. Investigation of Irradiation Facilities for FFHR Materials Development

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In the design study of FFHR (Force Free Helical Reactor), the replacement frequency of the blanket structural materials is required to be minimal during the reactor lifetime. The neutron flux and fluence of the structural materials anticipated by the reactor design side are 1.5MW/m^2 and 45MWa/m^2 (30years)[1]. This fluence is beyond the level where we will reach with realistic neutron sources such as IFMIF (International Fusion Materials Irradiation test Facility, d-Li type) within a reasonable test period. Thus, mechanistic irradiation studies which will provide a sound model-based prediction of materials performance to such high fluence level is crucial. For this purpose, it is needed to utilize a neutron irradiation facility with 14 MeV or its equivalent energy (spectrum), designed for the model calibration purposes, in addition to the present fission neutron and charged particle irradiation facilities. The objectives of the present study is to investigate neutron irradiation facilities which will contribute to enhancing the model-based predictability.

Based on the past irradiation studies with fission reactors, it is considered to be prerequisite for the irradiation facility to satisfy the following specifications.

(1) Irradiation flux at its high flux zone is above a level where the damage will reach several tens dpa in a year.

(2) The volume for the high flux zone should be over ~10cc.

(3) Good controllability of the irradiation condition and accessibility.

(4) Capability of in-situ measurements and variable condition experiments including change of spectrum.

The above flux and volume requirements are much smaller than those specified to IFMIF. However, the requirements are far beyond the level where any realistic type of D-T neutron irradiation facilities can satisfy. The present examination concluded that the d-Li type (IFMIF type) is the only possible candidate which can satisfy the flux and volume requirements.

Some engineering issues for the construction and the operation of the smaller d-Li neutron source were investigated. One of the largest advantages in downsizing the facility relative to IFMIF, in addition to curtailment of the cost, is the reduction of R&D for the development of some components (ion source, accelerator and target). According to the existing design study for IFMIF and ESNIT (Energy Selective Neutron Irradiation Test facility), it is concluded that no serious engineering issues for the construction and the operation of the smaller d-Li neutron source is expected.

The university group named the irradiation facility under consideration MIRAI (Materials Irradiation Research fAcility for fusIon). The concept of the MIRAI is under development. Emphasis has been placed on capabilities of in-situ measurements and variable flux, temperature and spectrum, which are not well furnished in the current IFMIF design. The test plan is also under discussion. The discussion is based on the materials issues for FFHR investigated in the recent paper[2].

Reference

1) Sagara, A., Motojima, O., Watanabe, K., Imagawa, S., Yamanishi, H., Mitarai, O., Satow, T., Tikaraishi, H., FFHR Group, Fusion Engineering and Design 29 (1995) 51.

2) Sagara, A., Muroga, T., Motojima, O., Noda, T., Tanaka, S., Terai, T., Kohyama, A. and Matsui, H., paper presented at 8th Int. Conf. on Fusion Reactor Materials, (Oct. 1997, Sendai), to be published in J. Nucl. Mater.