Plan and Progress of Strategic Material Irradiation Research with Domestic Existing Facilities toward Future Fusion Neutron Sources Preparation

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1. Introduction

In Korea, fusion energy roadmap to reach the DEMO and further fusion reactor(FR) has been embodied considering fusion neutrons sources (FNSs) to support engineering R&D like material, blanket, system engineering, licensing, code & standard and so on. Generally, for FNSs, small and large scale sources are considered as two step approach; compact accelerator based neutron source (CANS) for material and blanket irradiation test as separate effect test (SET), and volumetric fusion neutron source (V-FNS) for blanket R&D and final verification as Integral Effect Test (IET). In this presentation, current R&Ds are introduced to link the research of fusion materials to domestic existing facilities and also the plan for preparation of the next step of FNS.

2. Facilities and projects for fusion material irradiation research

Because each of them has its own advantage and limitation, a strategy is needed to develop fusion material irradiation research considering how to induce synergy with these ongoing projects. Considering the objectives of the FNSs, especially for the material irradiation test, the following facilities and on-going projects should be used to develop the DB and irradiation mechanism study

(1) HANARO irradiation test under ITER TBM program: thermal neutron, volumetric irradiation (larger specimen; standard or less), which can be used for irradiation DB up to 3 dpa comparing with unirradiation DB with ARAA of KO RAFM steel.

(2) A new project was started in this year to upgrade the heavy ion accelerator facility for ion irradiation test of fusion and fission materials. KAHIF heavy ion irradiation test under Fusion Preceding Program: Fe-ion irradiation test, surface irradiation (micro-specimen, high dpa effect) which can be used high dpa test, irradiation mechanism study.

(3) A cyclotron based neutron source has been developed with existing 30 MeV cyclotron at KAERI, which is used for radio-isotope production and newly used for developed for neutron radiography. High energy neutron, volumetric but limited dpa which can be used high energy neutron effect.

3. R&D for developing a new FNS

Furthermore, it can be also used to prepare the next step FNSs development for fusion material and breeding blanket focusing on CANS and more long-term strategy could be prepared.

(1) 30 MeV cyclotron can be used in beam driver (accelerator) selection, proton or deuterium, driver stability and so on for neutron production, especially for experience, target, maintenance etc.

(2) KoHLT-EB can be used target development like design and fabrication, which can supply the fusion and accelerator environment of high heat flux, especially for experiences from developing divertor/TBM-FW should be used in design, fabrication, performance test etc.

(3) KAERI nTOF irradiation building with DD/CANS can be used for developing shielding experiment and nuclear data like high accuracy cross-section library for FR, difference correction with thermal & fast & fusion neutron experiment, and more design margin for FR shielding (dramatic cost reduction is expected). For this, long-term R&D is needed to support library/shield and irradiation DB & simulation with shielding/licensed space. Currently, several Cf-252 and DD sources being used, new neutron source is needed for proposed R&D.

4. Conclusions and Future works

For embodying the KO fusion energy roadmap to reach the DEMO, FNSs to support engineering R&D like material, blanket, system engineering, licensing, code and standard etc. should be developed but we should more focus on the existing facilities and projects for easier and faster R&D and further the FNSs preparation. (1) Linking to preceding and parallel R&Ds for fusion material irradiation tests; DB, mechanism study, experience, expert training etc. (2) R&Ds for preparing (NOT developing) a new CANS type FNSs and basic & long-term R&D for FNS/DEMO/FR.

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