Chapter 1　Research Activities and Future Plans

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【Research Activities】

Research activity of the staff members of Oarai Center may be categorized into two, i.e. materials related field and nuclear fuel related field. As one of irradiation technique development, fabrication technique of pressurized creep tube of low activation vanadium alloys was developed for creep tests in liquid lithium environment and for irradiation creep tests [*1*]. Techniques involving precise tube drawing, EB-welding, high-pressure He gas filling with laser seal welding were successfully developed and excellent data have been obtained for un-irradiated creep experiments. Irradiation creep experiments are underway in JOYO at present under liquid sodium environments. Small specimen test technique will become more important for nuclear materials tests. The paper [*2*] describes a research conducted to examine the effect of specimen size on DBTT, where an evaluation method was proposed for the quantitative reduction of plastic constraint that is the major factor of the specimen size effect. The reduction of plastic constraints and its relationship with the specimen size and notch geometry was presented for high strength ferritic steels. The paper [*3*] describes a study to evaluate fracture toughness of Zr-based metal glass using miniaturized 3-point bend specimens.

Development of high-heat flux materials for fusion applications is among the important research subjects here and refractory metal alloy development with superior radiation resistance was successfully conducted based on the concept of ultra-refinement of grain size and particle dispersion. In tungsten, for instance, consolidation of sintered block with 99% relative density and grain refinement down to 100 to 200nm was successfully accomplished. For vanadium alloys, ultra-fine grain/particle dispersed V-(1.6-2.5)%Y alloy was prepared that showed no ductility loss by gaseous impurities, and its high temperature strength, neutron irradiation effects on its microstructure and mechanical properties were reported in the paper [*4*].

Hydride precipitates in fuel clad material in LWR has strong impact on the lifetime of cladding, therefore it is important to investigate its thermal properties. Phonon contribution to heat conduction of ZrH1.6　(δ-phase) was studied by a molecular dynamics method. In this study, thermal conductivity was theoretically estimated by nonequilibrium molecular dynamics

method[*5*]. It was concluded that hydrogen vibration to the heat conduction is very important at high temperature .

Another research topic related to nuclear fuel is described in the paper [*6*]. Comparison was made between a caluculation using existing nuclear data library and the analysis result of curium isotopes in the MOX fuel irradiated in Fast Experimental Reactor, JOYO. Here it is clearly shown that the calculation does not reproduce for an isotope higher than Cm-245. Experimental determination of high order curium isotopes in neutron-irradiated MOX fuel was conducted for the first time in this work and was awarded with the Promotion Award from AESJ.

1. K. Fukumoto, H. Matsui, M. Narui, T. Nagasaka, T. Muroga
Manufacturing pressurized creep tubes from highly purified V-4Cr-4Ti alloys,NIFS-Heat2
J. Nucl. Mater. 335 (2004) 103-107

2. Specimen Size Effects on Ductile-Brittle Transition Temperature in Charpy Impact Tesing,
H. Kurishita, T. Yamamoto, M. Narui, H. Suwarno, T. Yoshitake, Y. Yano, M. Yamazaki and H. Matsui:
J. Nucl. Mater. 329-333 (2004) 1107-1112.

3. A. Kawashima, T. Sato, N. Ohtsu and K. Asami
Characterization of surface of amorphous Ni-Nb-Ta-P alloys passivated in a 12kmol/m^3 HCl solution
Mater. Trans. 45 (2004)131-136

4. S. Kobayashi, Y. Tsuruoka, K. Nakai and H. Kurishita:
Effect of Fast Neutron Irradiation on the Microstructure in Particle Dispersed Ultra-Fine Grained V-Y Alloys:
Mater. Trans. 45 (2004) 29-33.

5. Konashi K., Ikeshoji T., Kawazoe T., and Matsui H.
Role of hydrogen in heat conduction in zirconium hydride
Trans. Mater. Res. Soc. Japan, 29, 8(2004)3811-3814.

6. M. Oasak, Shin-ichi Koyama, T. Mitsugashira
Analysis of curium in mixed oxide fuel irradiated in the experimental fast reactor JOYO for the evaluation of its transmutation behavior
J. Nucl. Sci. Tech., 41(9) (2004)907-914

【Plan】

In the materials irradiation field, pressurized creep tube developed in this year will be used for irradiation creep experiments in JOYO. For high temperature materials, the alloy design concept of ultra-fine grain/nano-particle dispersion will be further promoted in order to obtain a guideline for manufacturing high ductility materials. The research on zirconium hydride will be further developed by incorporating ab-initio calculations in addition to the classic molecular dynamics study. The study on metal-glass will be pushed forward by examining the correlation between the fabrication technique and fracture toughness. Study on the local corrosion characteristics is also planned on these materials.