2. Collaborations on Fusion Engineering

(1) Fusion Engineering Studies

In the fiscal year of 2007, 22 collaboration researches were carried out in Fusion Engineering Field. The researches were mainly supported by Fusion Engineering Research Center. The researches were categorized into three fields, namely the blanket system, the structural materials for high temperature application and the superconducting magnet system.

For the blanket system development, 7 reports were compiled here. The reports related to design activities will be presented in next section. The systematic understanding of the tritium and thermo-mechanical behavior in fusion blanket system proceeded and the aspects of properties change under irradiation were investigated. In addition, the coating technology was developed.

(1) Overall examination of tritium transfer and thermofluid control in fusion system (K. Okuno)
(2) Thermo-mechanical evaluation for Flibe test blanket module (H. Hashizume)
(3) Critical heat fluxes of subcooled water flow boiling in a short vertical tube at high liquid Reynolds number (K. Hata)
(4) Measurements of reaction rates and tritium production rates in Li/V-alloy assembly under 14 MeV neutron irradiation (T. Iida)
(5) Structural design of back-plate and its mechanical properties in weld zones on an intense neutron source for materials irradiation (K. Furuya)
(6) Radiation induced phenomena of hydrogen-doped perovskite-type oxide ceramics (T. Shikama)
(7) Development of oxide insulator coating process in advanced liquid breeder blanket systems (S. Yoshizawa)

The structural materials studied for high temperature application are SiC/SiC, vanadium alloy and reduced activation ferritic/martensitic steel. Since the related reports to the structural materials will be presented in the next section, it will be helpful to refer them. For SiC/SiC composite, the effect of constituents was discussed. As for the vanadium alloys, the new vanadium alloy with ultra-fine grains was developed, and the mechanical properties at elevated temperatures were clarified. Also, change in microstructure of laser welded joint of Y doped vanadium alloy by ion irradiation and deformation mechanism of Ti(OCN) precipitated alloy was discussed.

For reduced activation ferritic/martensitic steel, the fatigue property was investigated focused on test technique and complex inclusion effect. Also, deuterium trapping property and radiation damage by ion irradiation was studied. Regarding the modeling investigation, the effect of the radiation damage process was discussed.

(8) Effect of constituents on thermal and electrical conductivity of SiC/SiC composites (T. Hinoki)
(9) Development of highly pure, ultra-fine grained vanadium alloys with improved strength at high temperatures (H. Kurishita)
(10) Evaluation of mechanical properties and aging of high-chromium and yttrium-added vanadium alloys (M. Sato)
(11) The microstructure of laser welded Y doped V-4Cr-4Ti alloys after ion irradiation (H. Watanabe)
(12) Changes of deformation mechanism in V-Cr-Ti alloys by Ti(OCN) precipitation during aging process (K. Fukumoto)
(13) Development of reliable miniature-size fatigue test technique for reduced activation ferritic steels (S. Nogami)
(14) The influence of a complex inclusion on the LCF behavior of reduced activation ferritic/martensitic steels (A. Kohyama)
(15) Radiation damage and deuterium trapping property in ion irradiated ferritic steel (H. Iwakiri)
(16) Multiscale modeling of radiation damage processes in fusion materials (K. Morishita)

The fusion reactor will require the higher magnetic field, the higher current density and the excellent irradiation properties. The researches of the neutron irradiation effect on the superconducting magnet materials will be presented in sections of LHD related and Fusion Engineering Research center.

The evaluation of AC losses under cold-thermal fatigue and mechanical fatigue was performed. This study was the first trial and gave helpful results. Low activation superconducting materials, which consist of short decay periods elements, were investigated to improve the superconducting properties. V-Ti and V-Ti-Ta conductors showed the better critical current as well as MgB_2 conductors. However, those improved values are still lower than those of Nb_3Sn superconductors even in liquid helium temperature. Further consideration and investigation are necessary to produce reasonable and real superconductors for the fusion application.

The insulation material was characterized with fracture toughness for mode II. The irradiation effect on interlaminar shear strength will be evaluated based on the discussion presented in this report. The conventional evaluation process for fracture toughness with round bar samples was discussed.

(17) Influence of cold-thermal and mechanical fatigues on AC losses in superconducting coil (T. Takao)
(18) Development of V-Ti and V-Ti-Ta superconducting alloy conductors (K. Inoue)
(19) Fabrication of low activation MgB_2 mono-cored superconducting wire for fusion reactor (A. Kikuchi)
(20) Evaluation for superconducting property of extruded MgB_2/Al composite material wires fabricated via 3 dimensional penetration casting method (K. Matsuda)
(21) Cryogenic mode II interlaminar fracture toughness of composite insulation systems for superconducting materials (Y. Shindo)
(22) Standardization of the fracture toughness test method by round bar with circumferential notch (K. Kasaba)

(Sagara, A.)