2. Collaborations on Fusion Engineering

(1) Fusion Engineering Studies

In the fiscal year of 2008, 28 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, 12 reports were compiled here. The reports related to design activities will be presented in the next section. The systematic understanding of the behavior of functional materials, especially ceramics coatings, and tritium in fusion blanket systems proceeded and the aspects of properties change under irradiation were investigated. Also carried out were compatibility and thermo-mechanical behavior of liquid blanket components.

(1) Overall examination of tritium transfer and thermofluid control in fusion system (K. Okuno)
(2) Characterization of erbium oxide coating by irradiation induced luminescence (T. Nagasaki)
(3) Effect of neutron irradiation on tritium behaviors in fusion materials (Y. Hatano)
(4) Effect of constituents on thermal and electrical conductivity of SiC/SiC composites (T. Hinoki)
(5) Development of oxide insulator coating process in advanced liquid breeder blanket systems (S. Yoshizawa)
(6) Corrosion characteristics of ferritic steel JLF-1 in candidate breeder material Pb-17%Li for liquid blanket (M. Takahashi)
(7) Radiation induced behaviors of hydrogen trapped in oxide ceramics for fusion reactor blanket (B. Tsuchiya)
(8) Measurements of reaction rates and tritium production rates in Li/V-alloy assembly under 14 MeV neutron irradiation (T. Iida)
(9) Thermo-mechanical evaluation for Flibe test blanket module (H. Hashizume)
(10) Basic Design of Liquid Blanket with three-surface and three-layer coating (S. Itoh)
(11) Critical heat fluxes of subcooled water flow boiling in a short vertical tube at high liquid Reynolds number (K. Hata)
(12) Transmutation of high-level wastes by using volume neutron source (Y. Tanaka)

The structural materials studied for high temperature application were mainly for reduced activation ferritic/martensitic (RAFM) steels and vanadium alloys. For RAFM steels, the fatigue property was investigated focused on test technique and complex inclusion effect. Also carried out was the joining with austenitic steels. As for the vanadium alloys, characterization of weld joints and new vanadium alloy with high Cr or with ultra-fine grains was performed. Materials modeling and microstructural studies on plasma-wall interactions were also carried out.

(13) The influence of a complex inclusion on the LCF behavior of reduced activation ferritic/martensitic steels (A. Kohyama)
(14) Development of reliable miniature-size fatigue test technique for reduced activation ferritic steels (S. Nogami)
(15) Structural design of back-plate and its mechanical properties in weld zones on an intense neutron source for materials irradiation (K. Furuya)
(16) Feasibility study of helium concentration analysis in material by laser-induced plasma breakdown spectrometry (K. Fukumoto)
(17) The microstructure of laser welded Y doped V-4Cr-4Ti alloys after ion irradiation (H. Watanabe)
(18) Evaluation of mechanical properties and aging of high-Cr and Y-added vanadium alloys (M. Sato)
(19) Development of highly pure, ultra-fine grained vanadium alloys with improved strength at high temperatures (H. Kurishita)
(20) Multiscale modeling of radiation damage processes in fusion materials (K. Morishita)
(21) Radiation damage and deuterium trapping property in ion irradiated ferritic steel (H. Iwakiri)
(22) Thermal loads effects on erosion processes of helium irradiated tungsten (M. Miyamoto)

GFRP and Dyneema FRP (DFRP) were used for coil bobbins and Bi2223 tapes were wound and the better thermal flow from HTS into DFRP bobbin was confirmed. As for an organic insulation material, a cyanate ester GFRP and epoxy GFRP were fabricated using glass clothes and polyimide films. Neutron irradiation effect on interlaminar shear strength will be studied in the next year. The mixed mode interlaminar fracture toughness at 4 K of GFRP was investigated. FEM analysis showed that the damage increased the energy release rate. As for superconducting materials, RHQT (rapid-heating/quenching/transformation) process was developed to make V_3Ga wire. Test data will be provided in the next year. In addition, high Ga content V-Ga phases were investigated to create large volume fraction V_3Ga wire, and it was confirmed that 10 wt% Cu added V_2Ga/V precursor would form V_3Ga phase. Also, superconducting property of extruded MgB_2/Al wire was studied focused on an application of Mg-alloy (AZ91) for the matrix.

(23) Quench characteristics and structural materials in superconducting coil (T. Takao)
(24) Radiation effects of organic electric insulating materials (S. Nishijima)
(25) Cryogenic mixed-mode interlaminar fracture toughness of composite insulation systems for superconducting magnets (Y. Shindo)
(26) Development of V_3Ga conductors fabricated through composite precursor wires with Ga-coated V wires (K. Inoue)
(27) Development of V_3Ga superconducting wires by using V-Ga compound as high Ga source material (A. Kikuchi)
(28) Superconducting property of extruded MgB_2/Al composite material via 3 dimensional penetration casting method (K. Matsuda)

(Sagara, A.)