2. Collaborations on Fusion Engineering

(1) Fusion Engineering Studies

In the fiscal year of 2009, 27 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 materials for high temperature application and the superconducting magnet system.

For the blanket system development, 9 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, were enhanced. Also carried out were compatibility and thermo-mechanical behavior of liquid blanket components. Research on radiation-tritium synergism was also progressed.

(1) Overall examination of tritium transfer and thermofluid control in fusion system (K. Okuno)
(2) Characterization of erbium oxide coating by cathodoluminescence measurements (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) Corrosion tests of RAFM steel JLF-1 in lead-lithium (Pb-17Li) for 3000 hours (M. Takahashi)
(6) Radiation induced behavior of hydrogen isotopes retained in blanket oxide ceramics materials for fusion reactors (B. Tsuchiya)
(7) Tritium production rate measurement in Li/V-alloy assembly with 14 MeV neutron irradiation (T. Iida)
(8) Basic design of liquid blanket with three-surface and three-layer coating (S. Itoh)
(9) Critical heat fluxes of subcooled water flow boiling in a short vertical tube at high liquid Reynolds number (K. Hata)

Researches on materials for high temperature application were mainly for low activation structural materials such as reduced activation ferritic/martensitic (RAFM) steels and vanadium alloys, and plasma-facing materials. For RAFM steels, the fatigue property was investigated focused on the test technique. Also carried out was the research on the behavior of D and He in the materials. As for vanadium alloys, characterization of weld joints and new vanadium alloy with ultra-fine grains were performed. Materials modeling and microstructural processes on plasma-wall interactions were also carried out.

(10) Development of reliable miniature-size fatigue test technique for reduced activation ferritic steels (S. Nogami)
(11) Trapping behavior of deuterium in F82H ferritic/martensitic steel (H. Iwakiri)
(12) A study of helium concentration analysis in material by laser induced plasma breakdown spectrometry (K. Fukumoto)
(13) The microstructure of laser welded Y doped V-4Cr-4Ti alloys after ion irradiation (H. Watanabe)
(14) High temperature creep properties of ultra-fine grained, particle dispersed V-V-W-TiC Alloys (H. Kurishita)
(15) Measurement of mechanical strength of the first wall coating by means of laser-shock method (M. Sato)
(16) Multiscale modeling of radiation damage processes in fusion materials (K. Morishita)
(17) Thermal loads effects on erosion processes of helium irradiated high-melting PFMs (M. Miyamoto)
(18) Elucidation of mass transport on tungsten plasma facing material by surface analyses (K. Tokunaga)
(19) Formation mechanism of material mixing layers on first walls and their effect on hydrogen isotope retention (Y. Ueda)
(20) Development of the R curve fracture toughness test of round bar with circumferential notch by using hardening curves of each virtual crack length (K. Kasaba)

Flux pinning properties of DyBCO coated conductor under heavy ion irradiation were discussed. By theoretical model of flux creep and flow, the increase of critical current density could be explained. As for an organic insulation material, an epoxy resin with hardener (Jeffamine, D230 and D400) was investigated focused on glass transition temperature (Tg) under gamma ray irradiation. Coil bobbins were fabricated with GFRP and Dyneema FRP (DFRP) and Bi2223 tapes were wound. DFRP coil showed the smaller AC losses because of the negative expansion property of DFRP. Fracture toughness and fatigue growth behavior of SUS304 at 4 K were studied and the racture toughness was degraded and the fatigue growth rate was increased by 6 T magnetic field. V_3Ga superconducting wires were developed using V-Ga and Ti-Ga compound and the properties were investigated. Hi strengthened Bi2212 wire was fabricated with Ni sheath to reduce the amount of Silver (high activation under neutron irradiation) and to harden the wire surface. Also, extruded MgB_2/Al wire was produced and the In addition effect was studied.

(21) Flux pinning properties of defects nucleated by neutron irradiation in A15 type superconductor (M. Kiuchi)
(22) Radiation effects of organic electric insulation materials (S. Nishijima)
(23) Quench characteristics and structural materials in superconducting coil (T. Takao)
(24) Fracture and fatigue crack growth behavior of austenitic stainless steel in cryogenic high magnetic field environments (Y. Shindo)
(25) Development of V3Ga superconducting wires by using V-Ga and Ti-Ga compound as high Ga source material (A. Kikuchi)
(26) Investigation of the cross-sectional configuration of Ag sheath material for high strengthened Bi-2212 superconducting wire (Y. Yamada)
(27) Evaluation for superconducting property of extruded MgB2/Al composite material wires fabricated via 3 dimensional penetration casting method (K. Matsuda)

(Sagara, A.)