5. Basic, Applied and Innovative Researches

This section presents the research results from the wide area of the collaboration programs of NIFS in the fiscal year 2013. The number of reports has been increasing steadily, which might be the consequence of the stable base of fundamental plasma related researches of NIFS as a counterpart of the advanced plasma confinement research with the LHD device. The largest experimental device is HYPER-I for the basic plasma research, which gives plasmas produced by the 80 kW CW microwave of 2.45 GHz. Several kinds of gas species are used with precise mass flow control. Two topics of plasma experiment are reported. Intermittent phenomena were observed in the ECR plasmas and its 2-D images were taken using the image intensified CCD camera. Another topic is the coupling of the oscillations of neutral gas pressure and the microwave. In addition to these results, the improvement of the laser induced fluorescence diagnostics was also made.

For the plasma turbulence and fluctuation studies related to the transport, two topics are reported. The distribution of the phase velocity of measured fluctuation is shown in the transition phenomena of the edge transport barrier formation of CHS experiment. On the other hand, the frequency and the wave number spectra were measured for the basic turbulence experiment on the liquid crystal. The effect of the axial vector field on the turbulence was investigated using the rotating stage. Two basic plasma experiments for the negative ions were reported. The dependence of sheath potential on the negative ion concentration, the mass ratio of negative and positive ions are studied in order to contribute to the sheath model improvement. A combination of various experiments for the negative ion production was conducted for finding the more stable material surface design and developing reliable modeling.

For the plasma physics on the plasma flow, the MPD (magneto-plasma-dynamic) arc-jet experiment in Tohoku university showed the efficient plasma acceleration by adding a Laval-nozzle-type divergent magnetic field at the outlet of the thruster gun. The structure of shock wave in an arc-jet He plasmas were studied in Hiroshima university. The compression wave formed in the expansion region causes higher plasma density and the emission. The structure can be explained by the conventional compressive fluid dynamics.

Three research topics are reported for the material surface studies. The first one is on the carbon dust formation in the plasma discharges. Using a carbon anode and a carbon cathode, carbon dusts are produced with various sizes depending on the discharge duration time. In Kobe university, highly charged ions (HCIs) produced by an electron beam ion sources (EBIS) was irradiated on the surface of Er_2O_3 thin film for studying the luminescence from the Er_2O_3. The charge state of the beam is more effective to increase the luminescence than the kinetic energy of the beam. The reflection of positive and negative ions from the surface of silicon and carbon was investigated for different surface temperatures with variation of the reflection angles. The carbon surface showed the dependence of reflected ion intensity on the surface temperature while the silicon surface did not.

Two basic researches for the material tungsten were reported. The sputtering processes of the tungsten surface by ion impact was studied with an optical emission spectroscopy. The impact of Ar^+ ions was analyzed as well as the Kr^+ ions. It was confirmed that a large difference does not appear in the optical emission spectrum of the irradiated tungsten with different ion species. A new idea was proposed for the evaluation of tungsten materials by measuring the transition temperature of superconductivity. The nano-scale technology is adopted for using the focused ion beam (FIB). The experiment showed the higher temperature of superconductivity transition than the pure tungsten for the nano-scale tungsten wiring.

Notable progresses were made for the imaging science. In the electron microscopic tomography, the improvement in the algorithms of the Tikhonov-Phillips image reconstruction was obtained by introducing the nonlinear constraint to the solutions. For the microwave imaging reflectometer, two improvement in the hardware was made for the diffraction CT subsystem and the antenna of the pulsed radar subsystem.

Three reports were received from the experimental studies in the magnetic confinement devices in universities. In RT-1 experiment in Tokyo university, behaviors of high Z carbon impurities are studied in the aspect of the simulation of magnetosphere plasmas. The charge exchange process was taken into account in the analysis of carbon impurity dynamics. The physics of dynamo has been intensively studied in HIST device in Hyogo university. The coaxial helicity injection on HIST device was made to produce the toroidal plasma current and the structures of plasma flows were measured. A new diagnostics of the microwave interferometer imaging is now constructed. The experimental researches of field-reversed configuration (FRC) have been made in Nihon university. A new experiment of the translation of FRC plasma has been started in the FAT facility. The FRC plasma was translated successfully with the speed of 200 km/s without any disruption.

Finally various basic researches utilizing microwave technology have been conducted in the framework of NIFS collaboration programs. The permittivity of ceramics and metal powders were measured precisely for the basic database of the microwave application to the ceramic productions. In the field of renewable energy development, the study of the mechanism of direct saccharification of cellulosic materials with microwave is one of the most important research topics. The effect of crystal structure of tungstosilicic acid was investigated.

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