§27. Interaction and Structuring of Plasma and Condensed Matters by High-frequency Waves

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For the development of nuclear fusion plasmas, basic plasmas and reactor wall materials, the aim of this joint study is to advance basic researches and applications of nanomaterials and plasmas. Interactions of materials and high-frequency waves and properties of nanoscale materials are included in the scope of this research. Keywords of the study are the interaction of microwaves and far-infrared waves and phonons and materials, and developments of quantum-mechanical research methods to promote basic researches and its applications. Where, in both theories and experiments, deeper understandings about the physical properties of "nano-materials and plasmas" in the electromagnetic environment are obtained by participation of researchers from different fields related to high-temperature plasma researches. At the same time, the individual study is also promoted.

This joint research proceeds in a combination of two research modes. In the first mode, a practical joint research is carried out by small numbers of members on the common research theme “materials study by using classical and first-principles molecular dynamics, and Coulomb explosion process”. In the work process, numerical calculations are planned by group discussions and performed.

In the second mode, with the aim of discussion and presentation of the latest research on nano-materials and plasmas, many members from a wide range of research fields participate in a seminar. In the seminar, 1-hour lectures are given by the members. In the lectures, participants can make questions and comments to deepen their understandings.

The seminar was held at NIFS on December 16-17, 2031. 10 members working at the forefront of nano-materials and plasma researches participated in the seminar. Fig. 1 is a group-photo of the seminar. In the seminar, lectures on heating of dielectric-magnetic materials using a far-infrared and microwaves, structure formation and materials reaction via ultrasound, Coulomb explosion of pellets by laser irradiation, fusion neutron utilization, and hydrogen retention models in tungsten divertor materials were given by the participants. Results of the seminar contribute to developments of new researches in the fields of plasma, nuclear fusion, and manufacture of nano-materials.

An experimental study of the microwave field heating has been performed. As a result of the microwave magnetic field heating of an oxide magnetic substance (magnetite power), a nano-structure was created in the sintered body as shown in Fig. 2. The macroscopic magnetizations of samples were measured by SQUID without zero correction (Quantum Design MPMS-XL7). Fig. 3 shows the hysteresis loop of magnetite at 300 K. From TEM and SQUID data, it is suggest the sintered magnetite under magnetic field of microwave has super-ferrimagnetism.

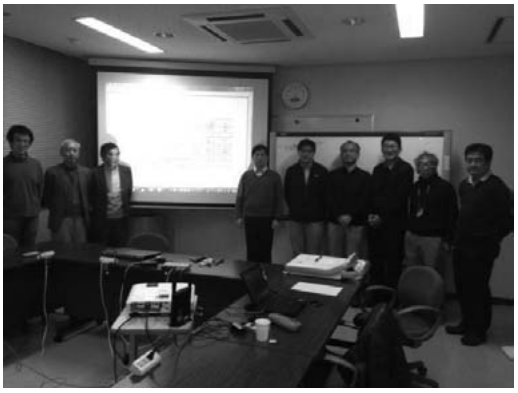

Fig. 1. Group-photo of the seminar at NIFS on December 16-17, 2013.

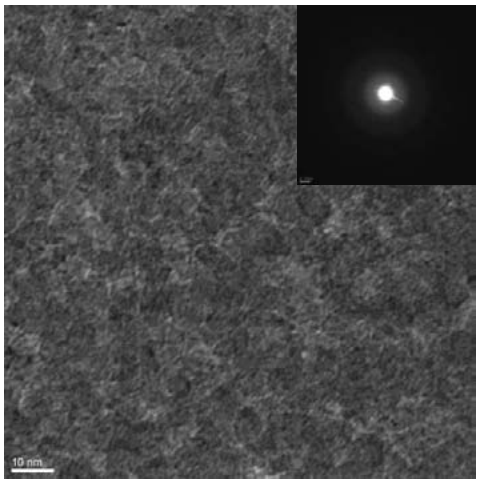

Fig. 2. A transmission electron microscope image of a sintered body of magnetite powders by the microwave magnetic field heating.

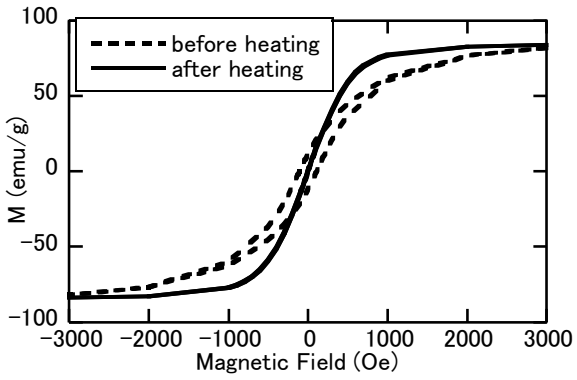

Fig.3 he hysteresis loop of the magnetite sintered by using magnetic field of microwave at 1000 °C.