§22. 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 hightemperature 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 firstprinciples 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 25th February, 2015. 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, participants discussed on the following themes:

- 1. Present status of nano-materials researches using firstprinciple molecular dynamics and prospect of post-K super computer.
- 2. New methods of multi-qubit quatum control for quantum computing.
- 3. Development of nano-structured materials and its applications for laser proton-beam acceleration.

- Time-dependent density functional calculations of dielectric response functions of materials and analysis of the dielectric response spectra using maximum entropy methods.
- 5. Experimental studies and theoretical modellings for micro-wave permittivity and penetration length of composites with dielectrics and conductors.
- 6. Theoretical modellings for micro-wave interactions with polycrystalline dielectrics.
- 7. Modelling of nano-bubble formations in water.
- 8. Wave propagations in plasmas with density variations.

This seminar series started in 1998. Topics covered by the seminars include magnetic reconnection, solar wind simulation, fist-principle molecular dynamics, carbon nanotube synthesis, quantum information technology, plasmawall interaction, micro-wave materials interaction, etc. Fruitful discussion and collaborations have been made through the seminar series. A new seminar series "Fundamental studies and applications of plasmas and nanomaterials" starting from the next fiscal year was proposed to take over this successful seminar series.

An experimental study on macro-wave heating of oxides were carried out. Developments of theoretical models were pursued in order to get better understanding on mechanisms of micro-wave heating of materials.



Fig. 1. Group-photo of the seminar at NIFS on 25th February, 2015.