Molecular structure and the vibration excitation levels of dusts formed in methane gas discharge

T. Kenmotsu, M. Nishiura[a], A. Itoh[a], H. Nakamura[a], M. Wada

Faculty of Life and Medical Sciences, Doshisha University, Kyotanabe, Kyoto 610-0394, Japan
[a]National Institute for Fusion Science, Toki, Gifu 509-5292, Japan

tkenmots@mail.doshisha.ac.jp

Dusts in plasmas attract extensive attention from the viewpoint of estimating the inventory of tritium atoms in a nuclear fusion device. The dusts are expected to absorb a considerable amount of tritium atoms and are distributed throughout a fusion device. Carbon made first walls of a fusion device emit carbon clusters and hydrocarbons, which diffuse into plasma and agglomerate to form dusts in low temperature edge plasma regions. Carbon dusts are also known to exist in cosmic space as the mean free paths for molecular attachment reactions are shorter than interstellar distances. The fundamental processes related to dust formation for these two different environment have not been understood completely yet. Thus, we have started a molecular dynamic (MD) simulation to investigate if gaseous phase reaction results in dust growth.

The simulation requires a long calculation time. Therefore, a small experimental setup to form dust in a gaseous environment has been designed and built to see if dusts can be actually formed in the apparatus in the manner that the simulation code predicts. The experimental chamber is made of a 10 cm diameter, 10 cm long cylindrical glass tube. A stable plasma is maintained by a dc glow discharge, and the plasma parameters are measured with a Langmuir probe. Typical electron temperature is usually below 1 eV, while the electron density ranges from 10^8 to 10^9 cm^{-3}. Figure 1 shows the electrode arrangement of our experimental setup. Dust can be introduced into the discharge by a dust feeder. Distribution of dust particles in the plasma is observed by illuminating the plasma with a planar He-Ne laser light.

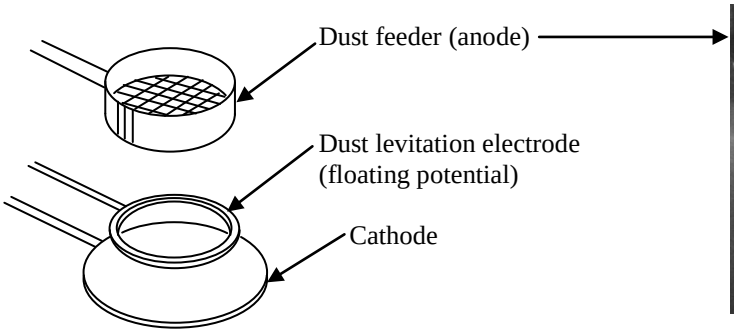

Fig. 1 Experimental setup

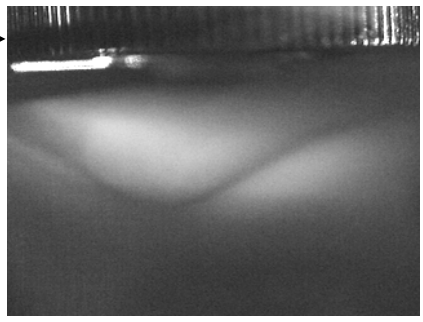

Fig. 2. Dust cloud below the dust feeder.

When the carbon dust was supplied to a hydrogen plasma from the dust feeder, a cloud was observed to be formed below the dust feeder. The particle size of the dust in the cloud was far much smaller than the originally supplied dusts. The mechanism that these finer dusts are levitated in the region far from the carbon dusts is being studied. Infrared spectra of carbon dust containing plasma are investigated to study characteristic behaviour of a plasma that forms carbon dusts. The observed infrared spectra will be compared with vibration energy levels of large hydrocarbon molecules predicted from MD calculations.