

Ion-induced nucleation experiment III: Approach to reaction kinetics

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Mechanisms of grain nucleation have attracted many researchers in connection with the formation of atmospheric aerosols and cosmic dust grains. Many works have been performed assuming homogeneous nucleation in gas phase or heterogeneous nucleation on the bulk surfaces. For the homogeneous nucleation, very high supersaturation condition is often required to gain the efficient formation rate over a "critical size" of particle, while the heterogeneous nucleation on the bulk surface may not be relevant to the first stage of grain formation in realistic environments. It is therefore reasonable to propose another nucleation mechanism occurring in the realistic environments. Ion-induced heterogeneous nucleation would be one of important mechanisms for the gas phase nucleation, because ion-neutral interaction can overcome the difficulty of the critical size expected in neutral-gas-phase homogeneous nucleation. In this context, we have started a series of experiments to clarify the early stage of the ion-induced nucleation, that is, cluster ion formation. For the first step, using a newly-developed apparatus, we measured the free energies of water-cluster ions at each size, of which parameters are closely related to the cluster formation rates. These results were presented in this session last year. As a next step, in order to directly investigate the reaction kinetics of cluster ions, we further developed an ion trap apparatus where charged particle can be stored within the volume of $\sim 0.5\text{cm}^3$ in vacuum for a long time. We will present the details of apparatus and the results of preliminary experiment.

Keywords: ion-induced nucleation, cluster ion, ion trap