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Analytical applications of small liquid droplets: From droplet-beam laser-ablation mass spectrometry to single-particle catalyst

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Abstract

Solution plays a main role in chemistry: Most of the synthetic and biochemical reactions as well as chemical analysis are performed in the solutions. In order to understand chemical dynamics in the solution in detail, we recently employ liquid droplets with sizes of tens of micrometer, which can be very well controlled in size, temperature, and production timing. By use of the liquid droplets, we investigate gas-phase protein dynamics, reactivity analysis of single-particle catalysts and so on.

The study on the gas-phase protein molecules is motivated to understand their intrinsic properties free from the perturbation of the solvent water molecules. We apply droplet-beam laser-ablation mass-spectrometry to isolate protein molecules in the gas phase by IR-laser ablation of aqueous protein solutions. Detailed mechanisms of their emergence in the gas phase are investigated because the gas-phase properties may depend on the isolation process. Multiply-charged hydrated protein clusters were produced by irradiation of the IR laser onto a droplet beam of aqueous solutions with various pH values prepared by addition of HCl or NaOH to the solution. The ions produced in the gas phase show significantly low abundance and have a lower number of charges on them than those in the aqueous solutions, which we explained using a nano-droplet model. On the other hand, as the extension of the liquid droplet studies, we are developing a novel apparatus to analyze activities of single-particle catalysts produced from the liquid droplet. Recent progress of the development is also presented.

Biography

Dr. Jun-ya Kohno obtained his PhD from Tokyo University, Japan, in 2000. He is now an associate professor at Department of Chemistry, Faculty of Science, Gakushuin University. His recent scientific interests focus on applications of liquid droplets to (1) a protein analysis in the gas phase, (2) formation and analysis of single-particle catalyst, (3) collisional chemical reactions of droplets, and (4) cavity enhanced droplet spectroscopy.