Laser Trapping and Raman Spectroscopy of Single Water Droplets in Air

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Aerosol water droplets play important roles in the earth's climate and in the atmospheric chemistry. Since the equilibrium size of an aqueous aerosol droplet is governed by the surface curvature and solute concentration under given relative humidity conditions, it is necessary to levitate a single water droplet individually in air and to investigate its properties as a function of the droplet diameter. Noncontact levitation of a single micrometer-sized water droplet in air can be achieved by a laser trapping technique and, therefore, the laser trapping technique is a powerful means to study the aerosol chemistry. Furthermore, a laser trapped water droplet in air can be employed as a spherical microcavity [1]. Since the refractive index of water (n = 1.33) is higher than that of air (n ~ 1.00), Raman scattering light from the inside of the droplet is reflected totally at the droplet/air boundary and it propagates circumferentially to produce standing waves at the boundary. This phenomenon is called whispering gallery mode (WGM) resonances and the Raman scattering is amplified by the WGM resonances in an aerosol water droplet (Figure 2). Therefore, Raman spectroscopy provides information on a unique fingerprint of size, composition, and temperature of an aerosol water droplet. In this study, we demonstrate the characterization of the chemical composition and size of an aerosol water droplet and the dependence of the equilibrium droplet size on relative humidity by means of laser trapping and Raman spectroscopy.

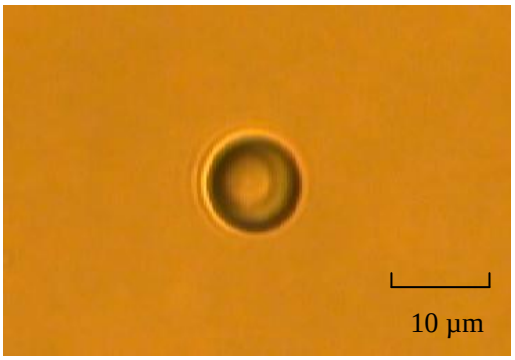

Figure 1. Photograph of a trapped water droplet

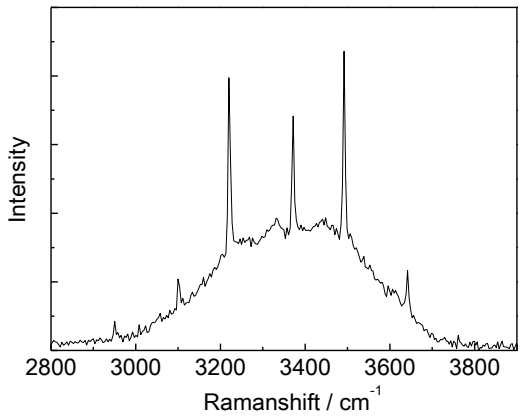

Figure 2. Raman spectrum of an aqueous aerosol droplet ($[NH_4]_2SO_4$ ~ 0.3 M, r = 4.549 μm)

References

[1] S. Ishizaka, Y. Suzuki, N. Kitamura, *Phys. Chem. Chem. Phys.*, **12**, 6852-6857 (2010)