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Raman Spectroscopy of Single Light-Absorbing Carbonaceous Particles Levitated in Air Using an Annular Laser Beam

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[Introduction]

Since soot can efficiently absorb sunlight, it acts as a heat source in the atmosphere. On the other hand, soot can act as cloud condensation nuclei (CCN) and decrease the temperature of the atmosphere. Due to these two conflicting roles, the net effect of soot particles on the global climate is complex. During the transport in the atmosphere, soot particles are subject to many complex physical and chemical process, which modify their morphology, chemical composition, hygroscopic properties. Despite the importance of fundamental knowledge about the chemical and physical properties that influence the CCN activity of soot, our current understanding of the aging processes of soot in the atmosphere remains limited. Since the chemical species in the gas phase were usually observed with a mass spectrometer, no information was provided about the single-particle level of soot properties. In this study, using a new laser trapping and Raman spectroscopy system, we achieved non-contact levitation and obtained Raman spectra of single soot particles in air.[1]

[Experiment]

Soot collected onto a watch-glass plate held above the burning flame of a candle were used for the experiment. A light-cage was formed at the focal point by using the laser beam (532nm, Coherent, Verdi V2). A glass capillary was manipulated to inject soot particles into the light-cage and Raman spectra of optically trapped soot particles were measured.

[Result and Discussion]

Single soot particle trapped in air is shown in Fig. 1. Since the trapping laser beam can be used simultaneously as an excitation light source for Raman spectroscopy, in situ characterization of single particles levitated in air can be achieved by means of Raman spectroscopy. As shown in Fig. 2, two intense peaks were observed at around 1350 and 1590 cm^{-1}, which are characteristic Raman bands of carbonaceous materials. We succeeded in the non-contact levitation of micrometer-sized soot particles in air and Raman spectroscopy of the optically trapped particles.

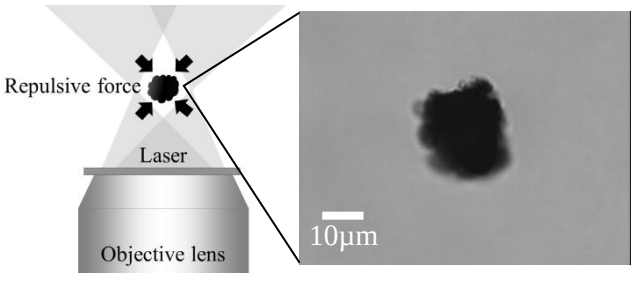

Fig.1: Single soot particle trapped in air

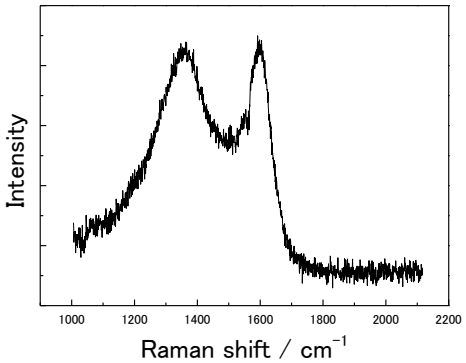

Fig.2: Raman spectrum of soot particle in air

[1] M. Uraoka, K. Maegawa, and S. Ishizaka, *Anal. Chem.*, DOI: 10.1021/acs.analchem.7b03455 (2017).