Application of SERS on the chemical analysis of nanometer sized aerosol particles

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New Particle Formation (NPF) is an important initial step for the aerosols to take shape, and both physical and chemical understanding of the ubiquitous phenomenon is needed to better quantify the climate impacts of the atmospheric aerosols. New particles are nanometer in scale, which makes them particularly difficult to sample and detect, therefore posing many technical challenges even as of today. The chemical speciation of the compounds involved in the NPF is technically challenging, because of the minute particle mass and short time involved in the event. There is a constant need for a more sensitive chemical analysis that can detect and resolve the evolution of the chemical compounds involved in the NPF events. In this study, we investigated the applicability of the surface enhanced Raman scattering (SERS) technique on the rapid and sensitive chemical analysis of nanometer sized aerosol particles. SERS provides a drastic enhancement of the scattering efficiency over traditional Raman spectroscopy. The novelty of the proposed technique is that the SERS substrate is directly used as the sampling substrate of the Spot Sampler (*Series 110 Liquid Spot Sample, Aerosol Device inc.*). The SERS substrate require the analyte in the form of water solution while Spot Sampler can activate nanometersized particles into liquid droplets. The condensation of water vapor by Spot Sampler ensures both innertial sampling and SERS pre-treatment simultaneously. In order to verify if the combined method using Spot Sampler and SERS substrate can be appled to chemical analysis of new particles, we generated ammonium sulfate and levoglucosan as the model particles and collected them directly on the SERS substrate (SERStrate, Silmeco) by Spot Sampler. Following analysis using Raman spectroscopy (Nanofinder HE, Tokyo Instruments inc.) demonstrated that the peaks of sulfate *v* (SO_4^{2-}) and organics *v* (C-H) can be detected even with the very weak laser power of 0.005mW. We conducted further test by generating mono-disperesed particles having diamters of 20nm, 50nm and 100nm, and the results suggested that although the quantitative interpreation of of the SERS spectra needs further work, the new method has high enough sensitivity and resolution which can be applied on the actual NPF events.

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