

All data under the file names "**Real SSA**" and "**Commercial**" are Raman spectra generated using LabRam HR Evolution Horiba Raman spectrometer equipped with an Olympus BX41 optical microscope. Spectra were obtained using the 100x microscope objective with a working distance of 7.6 mm and laser wavelength of 532 nm. X-ray photoelectron spectroscopy (XPS) spectra were generated using Kratos Axis Ultra X-ray photoelectron spectroscopy system. The lyophilized powder samples of LPS were pressed onto indium foil and mounted onto a copper stub. The X-ray gun was operated with a 10 mA emission current at an accelerating voltage of 15 kV. All are single particle spectra.

All data under the "**Real SSA**" file are authentic SSA particles generated during the 2014 Investigation into Marine Particle Chemistry and Transfer Science (IMPACTS) experiments. These particles were reacted on-the-fly with ~ 1 ppm of HNO_3 using a 5L flow tube reactor at a relative humidity of $\sim 60\%$ and temperature $30\text{--}35^\circ\text{C}$ and collected onto Quartz substrates (Ted Pella Inc., part no. 16001-1) using MOUDI prior to analyses.

All data labeled as "*Unreacted*" and "*Reacted*" under the "**Commercial**" file are of atomized (TSI Inc., model 3076) aqueous solutions (Optima water, Fischer Scientific) of commercial chemical species and substrate deposited (Quartz substrates, Ted Pella Inc., part no. 16001-1) prior to analyses. "*Unreacted*" are substrate-deposited particles and analyzed using Raman spectrometer. "*Reacted*" are substrate-deposited particles loaded into a reaction chamber and exposed to HNO_3 acid and water vapor for RH studies. Samples were exposed to ~ 1 ppm of HNO_3 at 20% RH for 10 min and then analyzed using Raman spectrometer.

Reacted (LPS_reacted_ATOFMS_ParticleNegSpectra) and unreacted (LPS_unreacted_ATOFMS_ParticleNegSpectra) particles generated by atomization of a solution of LPS were dried and then analyzed by a nozzle aerosol time of flight mass spectrometer. Particles were desorbed and ionized by a pulsed laser (266 nm wavelength, 8 ns pulse width, $700\ \mu\text{m}$ spot size, 1.1-1.3 mJ/pulse) generating single particle mass spectra. Single particle integer negative mass spectra are provided in each column, with the first column providing the

appropriate mass to charge value. Randomly sampled $n/10$ single particle mass spectra out of the entire dataset acquired are supplied.