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Imaging aerosol viscosity

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Organic aerosol particles play major roles in atmospheric chemistry, climate, and public health. Aerosol particle viscosity is important since it can determine the ability of chemical species such as oxidants, organics or water to diffuse into the particle bulk. Recent measurements indicate that OA may be present in highly viscous states; however, diffusion rates of small molecules such as water appear not to be limited by these high viscosities.

We have developed a technique for measuring viscosity that allows for the imaging of aerosol viscosity in micron sized aerosols through use of fluorescence lifetime imaging of viscosity sensitive dyes which are also known as 'molecular rotors'. These rotors can be introduced into laboratory generated aerosol by adding minute quantities of the rotor to aerosol precursor prior to aerosolization. Real world aerosols can also be studied by doping them in situ with the rotors. The doping is achieved through generation of ultrafine aerosol particles that contain the rotors; the ultrafine aerosol particles deliver the rotors to the aerosol of interest via impaction and coagulation. This work has been conducted both on aerosols deposited on microscope coverslips and on particles that are levitated in their true aerosol phase through the use of a bespoke optical trap developed at the Central Laser Facility. The technique allows for the direct observation of kinetic barriers caused by high viscosity and low diffusivity in aerosol particles. The technique is non-destructive thereby allowing for multiple experiments to be carried out on the same sample. It can dynamically quantify and track viscosity changes during atmospherically relevant processes such oxidation and hygroscopic growth (1).

This presentation will focus on the oxidation of aerosol particles composed of unsaturated and saturated organic species. It will discuss how the type of oxidant, oxidation rate and the composition of the oxidized products affect the time dependent aerosol viscosity.

(1) Hosny, N. A., C. Fitzgerald, A. Vysniauskas, T. Athanasiadis, T. Berkemeier, N. Uygur, U. Pöschl, M. Shiraiwa, M. Kalberer, F.D. Pope and M.K. Kuimova (2016) 'Direct imaging of changes in aerosol particle viscosity upon hydration and chemical aging'. Chemical Science, 17, 32194-32203. http://dx.doi.org/doi:10.1039/C5SC02959G