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Fluorescence lifetime imaging of aerosol viscosity and phase

F.D. Pope (1), N.A. Hosny (2), C. Fitzgerald (1), M. Kalberer (1), and M.K. Kuimova (2)

(1) Centre for Atmospheric Science, Department of Chemistry, University of Cambridge, Cambridge, United Kingdom, (2) Department of Chemistry, Imperial College London, London, United Kingdom.

The viscosity and phase of atmospheric aerosols are key properties that help define aerosol reactivity and hence aerosol aging. The viscosity and phase are strongly linked to the water content of aerosols and hence the aerosol hygroscopicity. The ability of chemical species to diffuse into the aerosol core, or be limited to surface reactions, is closely linked to the aerosol viscosity. In particular, the bulk reactivity of fast lived species with a limited lifetime is often diffusion limited.

At present, there is a paucity of analytical techniques that can directly measure the viscosity and phase of atmospheric aerosol. This limits the physical chemical understanding of these important aerosol properties. We are developing the use of Fluorescence Lifetime Imaging (FLIM) techniques, which have previously been used for investigating cell viscosity, to probe the viscosity of atmospheric aerosol.

The FLIM technique works by the insertion of novel fluorescent probes (molecular rotors) into the aerosol systems of interest (Kuimova et al.). The fluorescent lifetimes of these probes are dependent on the viscosity of the surrounding environment because the fluorescence competes with intramolecular rotation. In a highly viscous environment the rotation of the rotors is significantly hindered and hence the fluorescence is strongly perturbed. This technique allows the viscosity of model aerosols to be measured whilst varying the environmental conditions such as relative humidity and temperature.

Initial results on both inorganic and organic aerosol systems will be presented and the effect of relative humidity on aerosol viscosity will be shown. The applicability and future extensions of the FLIM technique for probing aerosol viscosity will be discussed.

Reference

M.K. Kuimova, S.W. Botchway, A.W. Parker, M. Balaz, H.A. Collins, H.L. Anderson, K. Suhling, P.R. Ogilby. (2009) Imaging intracellular viscosity of a single cell during photoinduced cell death. Nature Chemistry 1, 69-73.