Reactive oxygen species: links between particle chemical composition, emission sources and oxidation reactivity

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Air pollution, particularly due to particulate matter (PM), has adverse effects on human health. An important pathway underlying these effects is externally induced oxidative stress (e.g., by generation of reactive oxygen species), initiated by the interaction of PM with the human lung (Donaldson et al., 2002). Understanding the oxidative reactivity of nanoparticles could substantially contribute to explain their toxicity. A modified reactive oxygen species (ROS) online analyzer was employed to quantify particle phase ROS in real time, using a 2',7'-dichlorofluorescin (DCFH) based assay and calibrated by injecting known amounts of H_2O_2 (Fuller et al., 2014). Concomitantly, the aerosol chemical composition was quantified using an aerosol mass spectrometer (AMS).

We compared ROS concentrations measured by the same state of the art instrumentation in-situ with samples measured offline. This comparison indicates that, except the potential loss of sampling, 25-75% of the ROS material decayed during filter storage and manipulation, highlighting the importance of on-line methodologies.

Using the on-line setup, we compared the ROS content of particles from different sources including secondary organic aerosol from α-pinene ozonolysis, and primary and secondary particles from residential fuel combustion emissions. These emissions were generated under different conditions and aged using different photochemical reactors (including flow tubes and smog chambers). Additionally, the particle chemical composition and ROS content at two locations, Beijing (China) and Bern (Switzerland), were measured. Aging substantially increased the ROS content of the secondary organic aerosol (SOA), as indicated in Figure 1. Links between the ROS concentration and the different emitting sources and formation processes will be discussed.

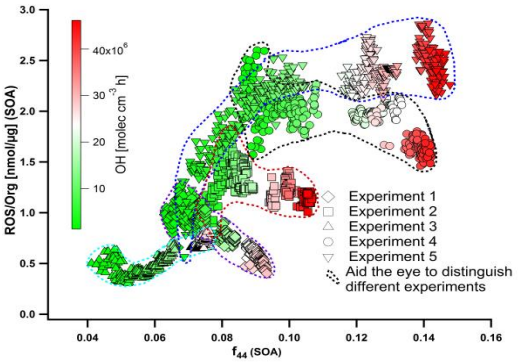

Figure 1. ROS content as a function of organic aerosol oxidation during biomass burning smog chamber experiments indicated by ROS/Org [nmol/µg] vs. f_{44} measured by AMS.

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