

The application of a novel profluorescent nitroxide probe to detect reactive oxygen species (ROS) related to secondary organic aerosol

B. Miljevic^{1,3}, T. Tritscher², J. Dommen², P.F. DeCarlo², A. Praplan², K.E. Fairfull-Smith³, S.E. Bottle³, U. Baltensperger², and Z.D. Ristovski¹

¹International Laboratory for Air Quality and Health, Queensland University of Technology, 4001, Brisbane, Australia

²Laboratory for Atmospheric Chemistry, Paul Scherrer Institute, 5232, Villigen, Switzerland

³ARC Centre of Excellence for Free Radical Chemistry and Biotechnology, Queensland University of Technology, 4001 Brisbane, Australia

Numerous studies have associated exposure to urban particulate matter (PM) with various adverse health effects. Widely accepted hypothesis for the PM-related injury is that the PM is able to generate ROS and in this way induce oxidative stress at the sites of deposition.

Secondary organic aerosols (SOA) make a significant contribution to the total atmospheric burden of fine particulate matter. Apart from the first results coming from the POLYSOA project, there aren't any published data regarding health effects of SOA. The aim of this study was to get an insight into the impact of SOA on human health in terms of their potential to induce oxidative stress. A new profluorescent nitroxide probe BPEAnit is used to detect and quantify ROS related to SOA particles. BPEAnit is weakly fluorescent, but yields strong fluorescence emission upon radical trapping or redox activity. SOA was generated in the PSI smog chamber using either isoprene, α -pinene or 1,3,5-trimethylbenzene (TMB) as a precursor. An overview of the experiments is shown in Table 1. All experiments were performed at 24°C and initial 50% relative humidity. SOA samples were collected by bubbling aerosol for 1 hour through an impinger containing 20 mL of 4 μ M BPEAnit solution, followed by fluorescence measurement. Both test and HEPA filtered control samples were collected in impingers. The amount of ROS was calculated from a standard curve obtained by plotting the known concentrations of methyl adduct of BPEAnit (fluorescent) against their fluorescence intensity at 485 nm. Based on the difference of fluorescence signal between test and control sample, the amount of ROS was calculated and normalized to the PM mass calculated from Scanning Mobility Particle Sizer (SMPS) measurements.

Representative examples of calculated ROS concentrations are given in Table 1 and examples of ROS concentrations of SOA samples taken at different times during two SOA formation experiments are shown in Figure 1. Overall, SOA-related ROS range from 7.7 to 84.6 nmol/mg, with SOA from isoprene showing the highest ROS concentrations and SOA from α -pinene the lowest. Interestingly, isoprene SOA shows a slight increase of ROS concentration with time, whereas α -pinene SOA shows a slight decrease in ROS concentration with time.

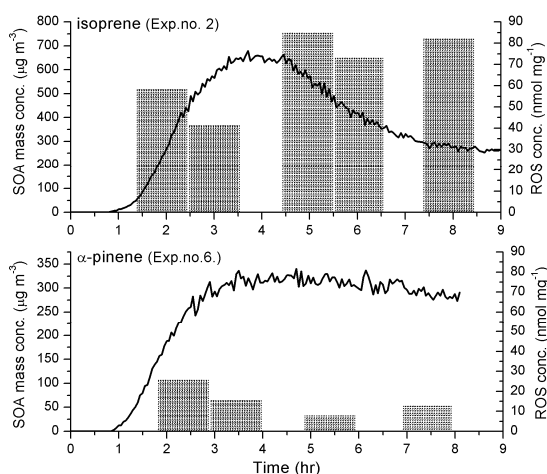


Figure 1. ROS concentrations and mass concentration of SOA for isoprene and α -pinene (impinger collection efficiency and density of SOA taken into account when calculating SOA mass).

Table 1. Overview of the experiments and ROS concentrations.

Exp. no.	SOA precursor	[precursor] /ppbV	[NOx] /ppbV	Time after lights on /hrs	[ROS]/nmol/mg of SOA
1	isoprene	4000	2000	1.5 – 2.5	35.6 ± 4.4
2	isoprene	5000	2500	4.5 – 5.5	43.4 ± 6.1
3	isoprene	5000	2500	1.5 – 2.5	58.0 ± 2.3
4	isoprene	5000	2500	4.5 – 5.5	84.6 ± 0.9
5	TMB	1500	750	2.7 – 3.7	63.6 ± 0.9
6	TMB	300	150	4.6 – 6.6	65.0 ± 0.8
7	TMB	300	150	1.8 – 2.8	31.9 ± 5.2
8	TMB	300	150	4.6 – 6.6	52.9 ± 5.4
9	α -pinene	240	120	1.8 – 2.8	25.6 ± 2.0
10	α -pinene	240	120	4.9 – 5.9	7.7 ± 1.5

This work was supported by the ESF project INTROP as well as the EC project EUROCHAMP.

References

Baltensperger, U., et al., *Combined determination of the chemical composition and of health effects of secondary organic aerosols: The POLYSOA project*. Journal of Aerosol Medicine and Pulmonary Drug Delivery, 2008. 21(1): p. 145-154.