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Real-time measurement of reactive oxygen species emitted from indoor sources

Reactive oxygen species (ROS) are considered to be an indicator of particle-induced toxicity. ROS can be either present on the surface of particles or generated through chemical reactions between particles and cells after inhalation. Therefore, measuring particle-bound ROS may be used to assess the harmful effects of inhaling particles. The purpose of this study was to determine ROS in real-time from six common indoor aerosols.

We use the Particle Into Nitroxide Quencher (PINQ) for real-time measurements of particle-bound ROS. Real-time assessment of ROS is advantageous for quantifying ROS since many species have short half-lives and cannot be detected by the more common measurement techniques that use filter sampling. Under laboratory conditions, we generated particles from indoor particle sources; frying of hamburgers, frying of potatoes, candle smoke, side-stream cigarette smoke, incense smoke, and secondary organic aerosol (SOA) formed from reactions between α-pinene and ozone. The generated particles were drawn into a chamber (25m3) from where the aerosol was sampled. In parallel, the particles' physicochemical properties were characterized. During measurements with PINQ, the chamber aerosol was alternatively sampled through a HEPA filter. This allows us to distinguish between the total phase and the gas phase. Without the filter, both particles and gas are measured. With a HEPA filter, particles are removed and the difference between the total and gas phase is the particle phase.

The highest total ROS concentrations were found in candle smoke, with 1,8 nmol/m3. SOA, cigarette smoke and incense smoke contained 0,53, 0,33 and 0,28 nmol/m3, respectively. ROS concentrations for aerosols generated by frying were lower. Since the particle concentration in the chamber differed between the experiments, the particle phase of the ROS concentration can also be expressed in nmol per particle mass. The highest ROS concentration was seen for SOA (0,57 nmol/mg) and cigarettes (0,35 nmol/mg). Burger and potato frying was close to zero, while incense and candle gave a negative response, that is, the gas phase gave a higher response than the total (gas + particle) phase. Obtained results and detailed characteristics of particles (mass and number concentration, and chemical composition) indicate that this is due to insoluble particles, especially black carbon, interfering with the fluorescent reading. This interference may also be present in cigarette smoke, giving an underestimation of the particle-bound ROS concentration.

The results of this study give insight into ROS concentration from indoor sources. Moreover, the concept of real-time ROS measurement with PINQ has been promising. It can be a powerful tool for screening particles for toxicity.

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