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Highlights of Analytical Chemistry in Switzerland

Characterization of Polymers in Nanometer Sized Atmospheric Aerosol Particles

Markus Kalberer*, Mirjam Sax, and Vera Samburova
Department of Chemistry and Applied Biosciences, ETH Zürich, Zürich

**Correspondence:* Dr. Markus Kalberer, Laboratorium für Organische Chemie Wolfgang-Pauli-Str. 10, ETH Hönggerberg, HCI E 330, CH–8093 Zürich
Tel. +41 1 633 48 34, Fax +41 1 632 12 92, E-Mail: kalberer@org.chem.ethz.ch

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Atmospheric aerosol particles of about 3 nm–10 μm diameter play a crucial role in many aspects of the earth's climate system. In recent years it also became evident that aerosol particles pose a public health problem, since studies showed that increased aerosol concentrations cause higher morbidity and mortality rates. The chemical composition of the particles is important in both climatological and health-related issues; however, it is only poorly understood. Atmospheric aerosols contain up to 50% organic material, but despite a large effort in the past decades not more than about 10–20% of the organic mass could be resolved on a molecular basis.

To identify and investigate their chemical composition organic aerosols were generated in a newly built smog chamber at the Paul Scherrer Institute (PSI) in Villigen, where organic particles can be generated under conditions similar to the ambient atmosphere. Due to the complex chemical mixture of compounds present in the aerosols a large variety of analytical techniques was used such as different mass spectrometric methods coupled with gas and liquid chromatography and infrared spectroscopy. The determination of the molecular weight distribution with Laser Desorption/Ionization Mass Spectrometry (LDI-MS) showed for the first time that up to 50% of the aerosol mass generated from anthropogenic and biogenic volatile organic precursors is composed of polymers with molecular masses up to about 900 Da. This result was a significant step towards a comprehensive knowledge of organic aerosol composition. Mass spectra of synthetic co-polymers formed from known oxidation products of important aerosol precursor compounds were compared with the smog chamber results and showed that a major fraction of the aerosol polymer can be explained by acetal polymerization of small carbonyls, which are abundant oxidation products of volatile organic compounds (VOCs).

A comparison with ambient aerosol samples collected at the ETH Zürich showed that the mass distribution of the polymeric fraction of the ambient samples closely matches the mass distribution of aerosols from biogenic VOC precursors. This result suggests that biogenic sources are a major contributor to the ambient organic aerosol mass even in urban areas.

The chemical characterization of these polymers is still at the very beginning and a large effort will be necessary to understand the influence of these compounds on health related issues and the climate.

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Reference

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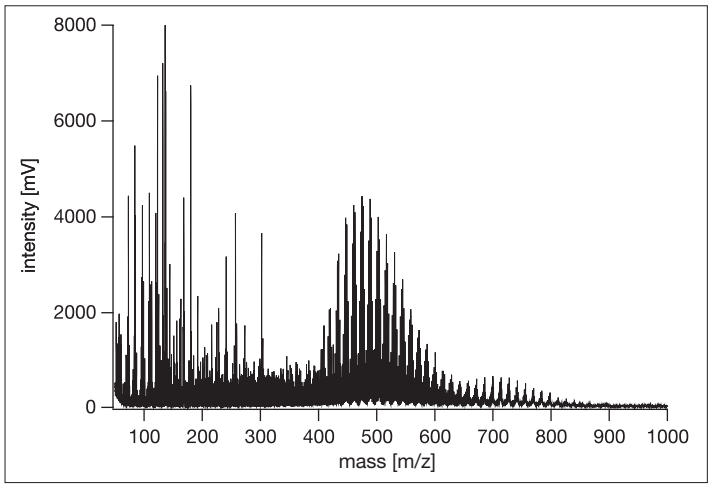
27 m^3 large smog chamber at PSI



LDI-MS spectrum from a smog chamber aerosol sample (Kalberer *et al.*, **2004**)

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Tel.: 071 274 77 87, Fax: 071 274 77 88, Mail to: veronika.meyer@empa.ch