Studying Atmospheric Aerosols by Acoustic Levitation: Linking Headspace Solid-Phase Microextraction (HS-SPME) with Gas Chromatography-Mass Spectrometry (GC-MS).

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Abstract

Climate change is one of the most important global environmental problems affecting natural ecosystems, food production, availability of fresh water as well as human health.[1] In acoustic levitation, a sound wave is generated between a piezoelectric transducer and a flat or concave reflector; therefore, by altering the distance between transducer and reflector a standing wave can be created and small samples of solids or liquids can be levitated.[2] This study has been conducted to improve our understanding of the reactions of O_3 and NO_3 with a range of terpenes found in the Earth's atmosphere and of the formation and properties of associated organic aerosols. Combination of acoustic levitation with gas chromatography-mass spectrometry (GC-MS) has been achieved for the first time using headspace solid-phase micro-extraction (HS-SPME); this combination leads to identification of several products, during reaction of oxygen, ozone and nitrate radicals with acoustically levitated droplets of α-pinene and d-limonene. The experimental set-up is illustrated in Fig.1.

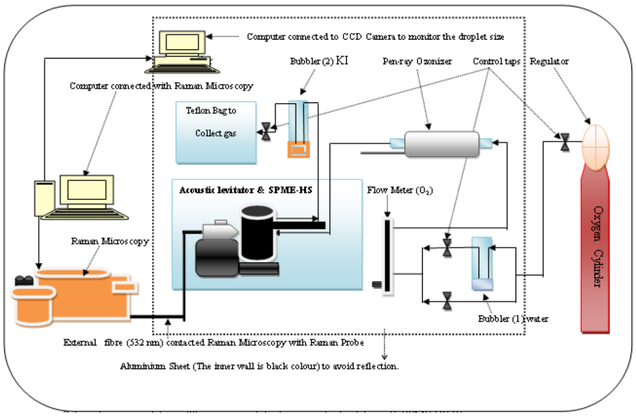

Fig.1: Experimental set-up for the acoustic levitator with HS-SPME-GC-MS analysis. The following conditions were employed: 174 mlmin^{-1} flow of N_2, 5 min extraction time, and using a 100-µm polydimethylsiloxane (PDMS) coated fibre.

Oxidation by oxygen and ozone of acoustically levitated droplets of α-pinene and d-limonene has been studied in an environmental chamber that allowed control of the gas-phase surroundings and relative humidity.

Several products for the reaction α- pinene with O_2 and O_3 could be identified mostly by comparison with reference samples in the same conditions including acetone, α-pinene epoxide, β-pinene, pinocarveol, verbenol, myrtenol, verbenone, pinenol, norpinone, norpinonaldehyde, and pinonoaldehyde. For the reaction of d-limonene with O_2 and O_3 the identified products are d-limonene oxide, carvone, carveol, limononaldehyde, carveol, keto-limononaldehyde, and limononic acid (see examples in Fig. 2 and Fig. 3).

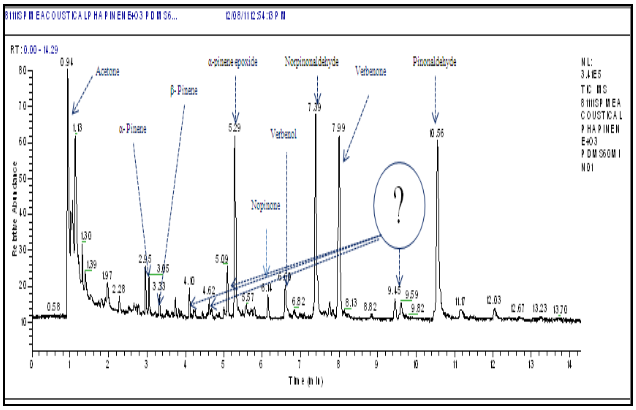

Figure 2: Products identified by HS-SPME-GC-MS for an acoustically levitated droplet of α-pinene after oxidative ageing (only GC trace shown for visual clarity).

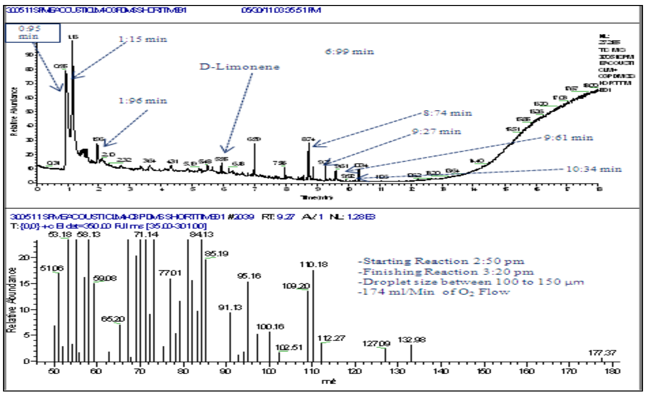

Fig. 3: Products identified by HS-SPME-GC-MS for a levitated droplet of d-limonene after oxidative ageing.

References.

1- Ravindranath, N.H., and J. A. Sathaye, *Climate Change and Developing Countries*, 2003, Kluwer Academic Publishers.

2- Priego-Capote, F., and L. Decastro, *Trends in Analytical Chemistry*, 25, 9 (2006).