Multi-Element Scanning Thermal Analysis (MESTA) of Aerosols and Nano-Carbon Particles

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A rapid and sensitive method for the chemical analysis of aerosols is highly desirable because aerosol samples are usually small, heterogeneous and easily contaminable. We report here the development of a multi-elemental scanning thermal analysis (MESTA) that can quickly and sensitively analyze aerosols with little or no pretreatment. Basically, the MESTA heats up a sample from ambient to 800 ^{o}C at a given heating rate and under a given atmosphere. The volatile during the heating is carried by a carrier gas to a high-temperature oxygenated quartz tube (1100 ^{o}C) where the C, N, S and H contents are oxidized to their respective oxides and detected by the respective detectors. The result of a MESTA is a C, N, S and H thermogram of a sample, which reveals the chemical/thermal character of the compounds in a sample. Since 2007, MESTA has been successfully applied to the analysis of aerosols, nano-carbons, and black carbons in environmental samples. MESTA can differentiate organic and inorganic forms of C, N and S rapidly and sensitively without pretreatment. It provides ample chemical signatures for the characterization and identification of aerosols. Present here are the MESTA results of aerosols from ambient air, forest fires and animal farms and nano-carbon samples. Aerosols of ambient air are enriched with low-temperature volatile N and S components, which are absorbed ammonia and organic sulfur, respectively. Forest fire emitted aerosols are lacking the low-temperature N and S components but enriched with more thermally stable (>350 ^{o}C) compounds. MESTA can not only differentiate sources of aerosols between biomass burning and ambient air, it can discern the aerosols produced from different combustion phases of a fire (smoldering or flaming or mixed). MESTA has also been used to examine the chemical/thermal properties of nano-carbons after oxidation or chemical processes. This study shows that MESTA may be a promising technique for analyzing aerosol and nano-crbon particles for management and research purposes.

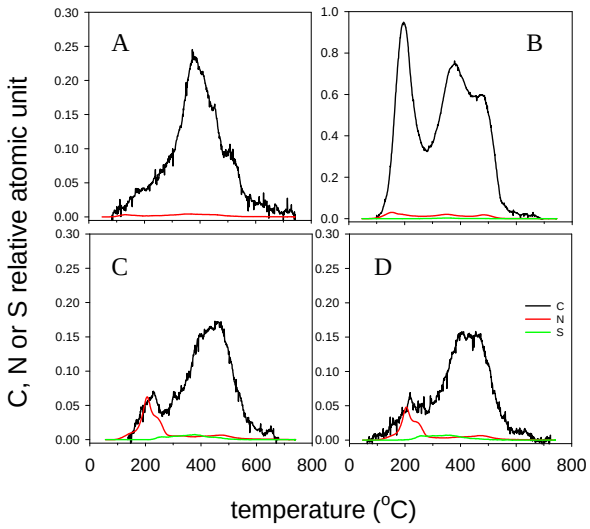

Figure 1. MESTA thermograms of PM2.5 collected at the burning (A), 14 hours after the burning (B), 58 h after the burning (C) and 148 h after burning (D).

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