

Source Classifying of Aerosols

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Recent attention has been focused on aerosol because of their various health risks particularly those linked to the respiratory system. These particles are produced both as a result of natural and anthropogenic actions (Seinfeld and Pandis, 1998). In urban environments anthropogenic emissions are a major source of particle mass. One study conducted in London in 1990 estimated that eighty six percent of all particle mass emissions are products of automotive emissions (UK QUARG, 1996). The small size of these particles permits them to be trapped in the lungs and cause chronic health problems (Ferin, 1992). Particle pollution has been blamed for heart disease, child asthma, inflammation, acute pulmonary toxicity and infant mortality (Kunzli, 2000; McAughey, 1997; Pope, 1995; Dockery, 1993; Seaton, 1995; Donaldson, 1998). The complex interaction of particles and humans is still not exactly known but the U.S. Environmental Protection Agency predicts that reducing particles emission could prevent fifteen thousand deaths a year (NRC News Report, 1998).

Often monitoring and measuring of ambient particles is conducted by means of filter based collection and lab analysis of samples. While this technique results in accurate and detailed characterization of ambient aerosol, it is time consuming and expensive. These measurements also are made at low temporal resolution and any information on the short time scale events are lost. A real time and automated measurement is essential to facilitate ambient aerosol characterization for health and environmental analysis. This device would require two phases, the first one separating the particles by their composition and the second phase counting the number. This research will concentrate on the first step.

Here we have developed a technique using photoelectric charging for source classification of aerosol particles. An ultraviolet excimer lamp (KrCl 222nm) irradiates the particles, resulting in an emission of electrons from the particle surface. The electrons discharge because their ionization energy is less than that of the protons. Microseconds after their separation, the electrons combine with oxygen molecules (Matter, et al, 1995). These negatively charged oxygen particles are then removed from the gas stream by an ion filter. The effect of the UV lamp on

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assorted particles depends on their size, photo threshold, and particle concentration. If there are more particles than 10^6 cm^{-3} the quantum yield reduces dramatically (Mohr, Burtscher, 1997). The UV charging results in high charges in particles with carbon surface.

In this research the photoelectric charger is utilized in a tandem differential mobility analyzer (TDMA) configuration. In a TDMA system, particles are size classified by one differential mobility analyzer (DMA), passed through a photoelectric charger and then size classified again by a second DMA. The change in the particle charge as it passes through the photoelectric charger is measured through tracking the change in the particle electric mobility using the second DMA. This setup with a photoelectric charger in a TDMA is referred to as a P-TDMA

Initial experiments were conducted using different aerosols. Laboratory experiments were performed with salt and candle particles using the P-TDMA setup. These experiments showed that salt particles were largely uncharged by the UV irradiation while the combustion particles were highly charged (Figure 1). The change in salt concentration as a function shows a mostly linear one to one relationship (Figure 2). The offset was due to experimental difficulty of keeping a constant salt flow. Later measurements with diesel and car exhaust also resulted in the expected high charging of combustion particles. Measurements are underway to correlate the experimental carbon and organic carbon as a function of particle charge response. The preliminary results with this technique suggest that the P-TDMA can be used to source classify and distinguish particles of different compositions.

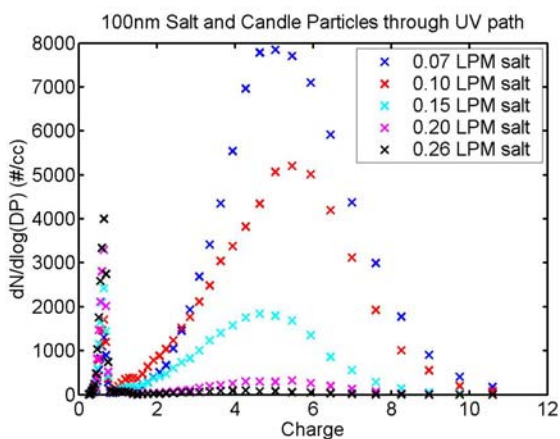


Figure 2

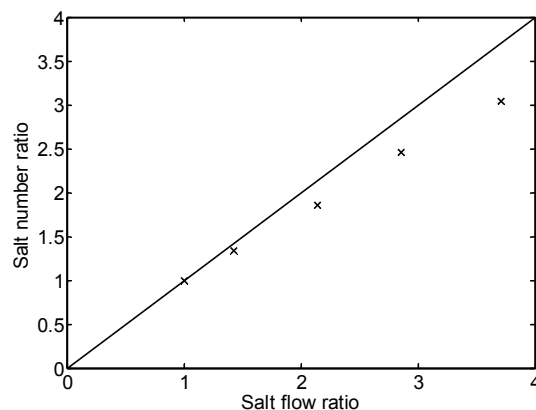


Figure 1

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