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EPA Agreement Number: R828771-0-01

Center Name and Institution of Ctr. Director: Center for Hazardous Substances in Urban Environments, Johns Hopkins University

Identifier Used by Center for Project: (Research Project #)

Title of Project: (sub-project): Single Particle Characterization of Ambient PM

Investigator(s) and Institution(s): Joseph J. Helble, University of Connecticut

Type of Research:

Project Period: August 2002 – August 2003

Objectives of Research: Understanding particle distribution functions and the particle-to-particle variations within that distribution are important for determining the potential health effects of urban aerosols. The objective of our project is to develop an understanding of the particle to particle variation in an ambient respirable aerosol downstream of an incinerator in an urban location. Our approach is to collect aerosol samples by deposition on a cascade impactor both in an incinerator stack and in a downwind region. Individual particle analysis is the most important aspect of this research and will then be used to obtain distribution functions. The morphology of individual particles will be examined by transmission electron microscopy (TEM).

Progress Summary/Accomplishments:

Ambient particles were collected at the Ponca Street site using a Berner type low-pressure impactor (LPI). This impactor has eleven stages capturing decreasing sizes of particles. For our study we selected stages 1, 4, 6, and 8, corresponding to mean aerodynamic diameters of 0.13 μm , 0.15 μm , 0.58 μm , and 2.1 μm . Ambient particles were captured by impaction on a transmission electron microscope (TEM) indexed grids affixed directly to the impaction stage of the LPI. In the Ponca Street study, sampling times of 1 hour were used to obtain sample with the exception of some early samples in which two hour collection periods were used. Samples were collected in early morning (7:30am to 8:30am), midday (12:30pm to 1:30pm), afternoon (5:30pm to 6:30pm), and nighttime (9:30pm to 10:30pm) periods for five weekdays. Weekend sampling was not possible because of rainy conditions.

TEM images of particles were taken at magnifications of 8200x, 3300x, and 490x. Higher magnifications were used for specific areas containing smaller particles. These particles were taken into account by scaling their number by the difference in magnification. A minimum of 30 particles per area was studied; most images contained between 60 to 100 particles. Particle contours were manually thresholded due to poor quality of most of TEM negatives. The image analysis software Scion Image (National Institutes of Health)

was used to count particles and to extract X,Y coordinates of particle profiles. Border-based fractal dimensions (D_f) were then obtained for each stage, and histograms of the counts versus the fractal dimension for each stage generated. Using these data, lognormal probability density functions (PDFs) of fractal dimension were generated.

Figure 1 presents two micrographs showing fine particles collected during early morning sampling at Ponca Street in November 2002. In Figure 1a, particles corresponding to stage 1 are displayed. A variety of morphologies ranging from coarse to fractal-like aggregates are evident. In Figure 1b, corresponding to stage 4, fractal-like aggregates appear to dominate. These are likely soot particles resulting from motor vehicle traffic during the high traffic density morning sampling period. Figure 2 presents a preliminary PDFs for an early morning sample obtained from stage 4. The lognormal PDF has a mean value of fractal dimension larger than 1.1 reflecting the fractal-like character of the particles sampled.

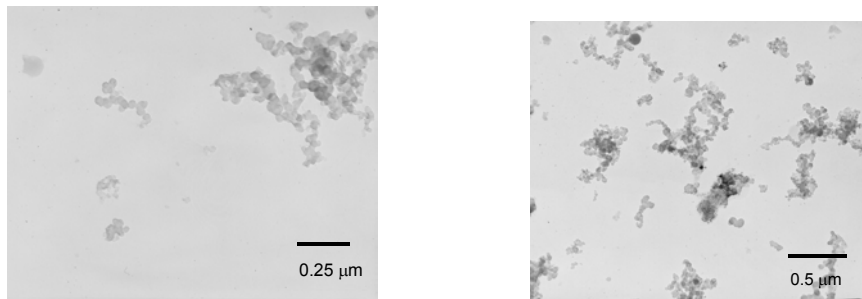


Figure 1 (a) (left) stage 1 particles; (b) (right) stage 4 particles.

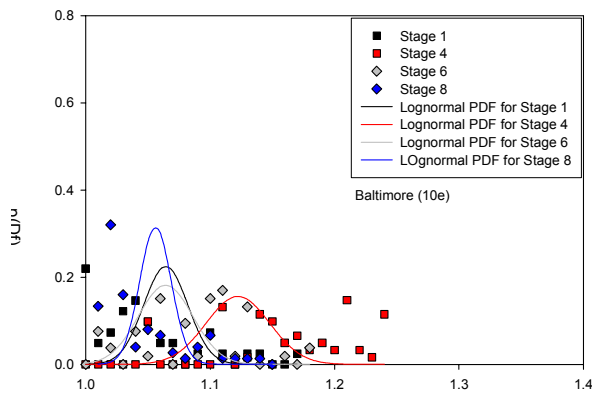


Figure 2 Morphology (border based fractal dimension) PDF for an early morning Ponca Street sample

Publications/Presentations: Mamani, R.M., and Helble, J.J., Structural Characterization of Ambient Fine Particulate Matter at an Urban Site, 21st Annual Mtg. of the Amer. Assoc. for Aerosol Research (poster), Charlotte NC, October (2002).

Future Activities: Completion of data analysis for Ponca Street samples. Plume sampling is to be conducted in parallel with plume sampling by LIDAR and thus remains dependent upon the availability and scheduling of the LIDAR system.

A one year no cost extension has been granted for the completion of the data analysis component of the project.

Supplemental Keywords: PM 2.5, morphology, chemical composition

Relevant Web Sites: N/A