BNL-90566-2009-AB

LIGHT ABSORPTION BY COATED SOOT

Sedlacek III, A. J., Lee, J., Onasch, T., Davidovits, P., and Cross, E. S.

For presentation at the
2009 American Geophysical Union Fall Meeting
San Francisco, CA
Dec. 14-18, 2009

Environmental Sciences Department/Atmospheric Sciences Division
Brookhaven National Laboratory
P.O. Box, Upton, NY
www.bnl.gov

ABSTRACT

The contribution of aerosol absorption on direct radiative forcing is still an active area of research, in part, because aerosol extinction is dominated by light scattering and, in part, because the primary absorbing aerosol of interest, soot, exhibits complex aging behavior that alters its optical properties. The consequences of this can be evidenced by the work of Ramanathan and Carmichael (2008) who suggest that incorporating the atmospheric heating due to brown clouds (plumes containing soot byproducts from automobiles, biomass burning, wood-burning kitchen stoves, and coal-fired power plants) will increase black carbon (BC) radiative forcing from the Intergovernmental Panel on Climate Change best estimate of 0.34 Wm-2 (±0.25 Wm-2) (IPCC 2007) to 0.9 Wm-2. This noteworthy degree of the uncertainty is due largely to the interdependence of BC optical properties on particle mixing state and aggregate morphology, each of which changes as the particle ages in the atmosphere and becomes encapsulated within a coating of inorganic and/or organic substances. With the advent of techniques that can directly measure aerosol light absorption with influences due to collection substrate or light scattering (e.g., photoacoustic spectroscopy (Arnott et al., 2005; Lack et al., 2006) and photothermal interferometry (Sedlacek and Lee 2007)) the potential exists for quantifying this interdependence.

In July 2008, a laboratory-based measurement campaign, led by Boston College and Aerodyne, was initiated to begin addressing this interdependence. To achieve this objective measurements of both the optical and physical properties of flame-generated soot under nascent, coated and denuded conditions were conducted. In this paper, light absorption by dioctyl sebacate (DOS) encapsulated soot and sulfuric acid coated soot using the technique of photothermal interferometry will be presented. In the case of DOS-coated soot, a monotonic increase in light absorption as a function DOS coating thickness to nearly 100% is observed. This observation is consistent with a coating-induced amplification in particle light absorption. (Bond et al. 2006) However, in contrast to this, light absorption by sulfuric acid coated soot displays unexpectedly complex behavior where the degree of amplification appears to be dependent upon the underlying soot core diameter. These preliminary results will be presented.

References

Arnott, W. P., Hamsha, K., Moosmüller, H., Sheridan, P. J., and Ogren, J. A. Towards aerosol light absorption measurements with a 7-wavelength Aethalometer: Evaluation with a Photoacoustic instrument and a 3 wavelength nephelometer. *Aerosol Sci. Tech*. 39, 17-39 (2005).

Bond, T. C., G. Habib, and R. W. Bergstrom. Limitations in the enhancement of visible light absorption due to mixing state, *J. Geophys. Res*. 111, D20,211, doi:10.1029/2006/JD007,315 (2006).

Lack, D. A., Lovejoy, E. R., Baynard, T., Pettersson, A., and Ravishankara, A. R. Aerosol Absorption Measurement using Photoacoustic Spectroscopy: Sensitivity, Calibration, and Uncertainty Developments. *Aerosol Sci. Technol*. 40, 697-708 (2006).

Ramanathan, V., and Carmichael, G. Global and regional climate changes due to black carbon. *Nature Geoscience* 1, 221-227 (2008).

Sedlacek, A. J., and Lee, L. Photothermal interferometric aerosol absorption spectrometry. *J. Aerosol Sci*. 41, 1089-1101 (2007).