AN INSTRUMENT FOR MEASURING AEROSOL LIGHT ABSORPTION USING PHOTOTHERMAL INTERFEROMETRY

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A 19 inch-rack size instrument for the measurement of light absorption from aerosol particles was fabricated utilizing a refractive index sensitive interferometer. This instrument uses the photothermal technique based on a configuration of the folded-Jamin interferometer, updating the previous instrument (Moosmüller & Arnott, 1996). Absorbing aerosol is introduced into the sample cell, which is traversed by both reference beam and probe beam. Our photothermal interferometer measures a signal caused by a periodic irradiation of the probe beam volume by the pump beam. The frequency of the pump laser is set to 1 kHz.

Preliminary measurement of light absorption from spark-generated carbon particles confirmed the feasibility of our photothermal interferometer. A spark discharger (DNP 2000, Palas, GmbH) generated carbon soot particles, morphologically similar to diesel soot, with nitrogen being used as a carrier gas. The size distribution of these carbon particles was measured using a home-made differential mobility analyzer (DMA, home-made) and a condensation particle counter (CPC, TSI 3775). The mode diameter was measured to be 120 nm at a spark frequency of 148 Hz and 2 bar of input pressure for the spark discharger. We classified 120-nm diameter carbon particles with a constant number density of 1.7×10^5 #/cc as input for our photothermal interferometer. The flow rate into the sample cell was maintained at 0.255 lpm. Digital signal processing was implemented using a lock-in amplifier (Stanford Research System, SRS 830) for the phase-sensitive detection of the photothermal interferometric signal due to absorption by the carbon particles, resulting in a signal of ~3.48 μV. Assuming spherical black carbon particles, we obtain the volume fraction of the spark discharged black carbon as $\sim 1.54 \times 10^{-10}$. An effective density for spark-generated black carbon around 120-nm diameter can be extrapolated to 0.555 g/cc from that for 200-nm diameter one reported by Gysel et al. (2012). From that, the mass concentration of the spark-generated black carbon is calculated to be 85.3 $\mu g/m^3$.

Currently, systematic improvement of the optical arrangement is in progress for better sensitivity enabling monitoring of atmospherically relevant black carbon aerosols. These improvements will be discussed in detail.

REFERENCES

Gysel et al., 2012, Atmos. Meas. Tech., 5, 3099-3107.
Moosmüller & Arnott, 1996, Opt. Lett., 21, 438-440.