Variation of absorption and scattering coefficients of single diameter black carbon aerosol with coating

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Black carbon aerosols (BC), which are produced by incomplete combustion, may significantly affect climate because they absorbs solar radiation to heat ambient atmosphere. To reduce uncertainty in climate effect of BC particles, accurate measurement of absorption and scattering coefficients of BC is significant. One of significant issue is the lenzing effect: enhancement of absorption coefficient of BC particle due to coating of other liquid material such as organics.

We have developed a system to produce aerosol particle of a single diameter by the combination of DMA and APM instruments. We also succeeded to coat organics on BC particles, and the thickness of the coating can be selected. By using PASS and PSAP for measuring absorption coefficient, Nephelometer for measuring scattering coefficient, CRDS for measuring extinction coefficient, we have measured radiation characteristics of two type of BC particles, Nigrosin and Aqua Black, especially the lenzing effect.

The measured absorption cross section of Nigrosin is 0.012×10^{-8} cm^2 at Dp = 150 nm, and 0.28×10^{-8} cm^2 at Dp = 500 nm. That of AquaBlack is 0.015×10^{-8} m^2 at 150 nm, and 0.30×10^{-8} cm^2

at Dp = 500nm. In comparison with PASS, PSAP overestimated the absorption coefficient by 3 to 28%, larger for smaller particles.

Lenzing effect is estimated by the relationship between increase of absorption cross section of BC particles in terms of the ratio of total diameter (Dp) including coating to the diameter (Dc) of BC core paticle, Dp/Dc. In the case of Nigrosin particle, the absorption cross section increased by a factor of 2 at Dp/DC = 1.5 for Dc = 200 nm, and the cross section did not increased significantly when Dp/Dc is larger than 1.5. In the case of Aqua black particle, the absorption cross section increased by a factor of about 1.5 at Dp/DC = 1.5 for Dc = 200 nm, and the cross section did not also increased significantly when Dp/Dc is larger than 1.5. The absorption cross section measured by PSAP did not show any lenzing effect, and it rather decreased with the coating, showing that the absorption cross section of coated BC particles can not be measured accurately by PSAP.

The scattering and extinction coefficients of coated BC particles increased with the Dc/Dp values. They are a factor of about 40 and about 20, respectively, in the case of Dc=200 nm and Dp/Dc = 3.