Light absorbing properties of diesel exhaust particles measured by a three-wavelength photoacoustic spectrometer

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Experimental

A three-wavelength photoacoustic soot spectrometer (405, 532, and 781 nm) was used to investigate the wavelength-dependent optical properties of diesel exhaust particles (DEP) emitted from a diesel engine vehicle running on a chassis dynamometer in a transient driving mode (JE-05) and a constant speed mode (either idling or driving at 70 km/h). The optical properties were measured after passing the diluted exhaust through a heater, which was controlled at 20, 47, or 300°C (transient driving mode) or between 20 and 400°C (constant driving mode). The OM accounted for on average ~40 and ~35% of the total mass concentration of DEP during the transient and constant driving modes, respectively.

Results and discussion

In the transient driving mode, enhancement of the scattering coefficients at 20 and 47°C, as well as the mass concentration of organics, was observed during the "high-speed driving period (~80 km/h)" corresponding to driving on a highway. No enhancement of the light absorption due to coating (the lensing effect) was observed for either the transient (including the "high-speed driving period") or constant driving modes, possibly because organic matter (OM) was mainly externally mixed with the black carbon (BC) in the fresh DEP under our experimental conditions.

By comparing the wavelength dependence of the absorption coefficients with and without heating, the contributions to total light absorption at 405 nm by OM was estimated. A significant contribution by light-absorbing OM (20 ± 7%) to total light absorption at 405 nm was observed during the "high speed driving period" of the JE-05 mode, while the contributions were small during the other periods in the JE-05 mode and the constant driving mode.