Refractive index function of soot formed under different conditions. Application to climate change

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Soot particles appearing due to human activity are known to be responsible for climate impact. The soot aerosol deposited on glaciers reduces snow albedo and increases surface melt. The soot aerosol in atmosphere results in sun light shielding and global temperature decrease. Thus, the optical properties of soot particles are important for development of reliable climate models. However, a wide variation of soot properties is observed in dependence on formation conditions. In this study, soot nanoparticles were synthesized by ethylene, acetylene and propylene combustion in a flat premixed flame and by pyrolysis of the same hydrocarbons in a shock tube at temperatures of 1800–2000 K and a pressure of 3–4 atm. The absolute value of the refractive index functions of soot nanoparticles E(m,1064) at wavelength 1064 nm, the ratio of the refractive index functions at two laser wavelengths of 532 nm and 1064 nm and internal soot structure were studied in dependence on soot primary particle size. It was found that soot refractive index function increases with soot particle size and does not exceed the value of 0.45. Change in the optical properties of soot is attributed to a decrease of interlayer spacing in the soot basic structural units. Soot growth process resulted in soot graphitization, optical bandgap decrease and an increase in the light absorption at longer wavelength. The obtained results allowed clarifying a visible and near IR absorption of diversity soot particles dispersed in atmosphere and deposited on ice surface. This study was funded by Russian Science Foundation, project No. 19-79-10204.