INVESTIGATION OF HEATED AND COLD CARBONACEOUS NANOPARTICLES OPTICAL PROPERTIES

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Work-In-Progress Abstract

Laser-Induced incandescence (LII) technique is a powerful tool for measuring concentration and size of carbonaceous particles. The technique involves heating soot particles to the incandescence temperature, using a high-power, pulsed laser. Laser heating od soot during LII measurements has been proved to modify the particles internal structure and promote the formation of new particles as a result of a vaporization effect. In addition, recently, the possibility of a permanent or reversible change in the optical properties of laser-heated soot particles has been considered and investigated, since this change might affect the LII signals and should be accounted for in the interpretation of the data. Although, this issue is far from being solved and more detailed studies are needed to understand the impact of the variation of soot optical properties on LII measurements.

The aim of the present work is to investigate the effect of rapid laser heating on soot nanoparticles absorption properties. To this purpose, wavelength-resolved extinction measurements during and after laser irradiation were performed in the visible spectral range. The spectral behaviour of soot absorption properties was explored at the LII prompt signal, when particles reach the maximum temperature, and few tenths of second after the laser pulse, when particles are already cooled down to the surrounding environment temperature. Measurements were performed at different laser density energy: low fluence (130 mJ/cm^2 - IR-LF), medium fluence (260 mJ/cm^2 - IR-MF) and high fluence (400 mJ/cm^2 - IR-HF). Cold soot particles of different age and maturity were produced by Nitrogen-quenched diffusion flames.

Figure 1 shows the spectral behaviour of the absorption coefficient for cold and heated carbonaceous nanoparticles.

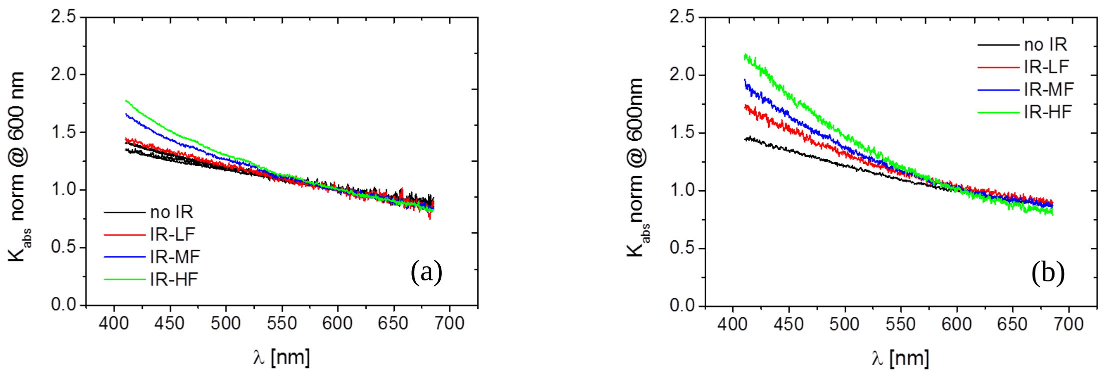

Figure 1. Absorption coefficient spectral behavior of cold and laser-heated particles. measurements at the LII peak, (b) measurements few tenths of second after the laser pulse

The curves were normalized at 600 nm in order to account for a possible variation in the particles concentration.

A significant spectral variation of the absorption coefficient of the laser-heated soot nanoparticles compared to the absorption coefficient of the non-heated ones can be observed (Fig. 1a). In particular, while above 550 nm the spectra tend to flatten, for lower wavelengths a significant increase of the absorption coefficient is detected for the heated soot nanoparticles. A similar behaviour was observed also few tenths of a second after the laser irradiation (Fig, 1b), suggesting that particles undergo an important permanent structural modification.

Therefore, it is reasonable to state that these observations establish new guidelines for a correct application and interpretation of the LII technique.