Experimental study of particle vaporization under pulse laser heating by LII and laser light extinction

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Particle vaporization is one of the uncertainties in LII measurements of particle size or volume fraction. The common recommended threshold of energy fluence for soot vaporization is in the range of 0.1-0.2 J/cm^2. However, for non-soot particles or for carbonaceous particles different from soot, the vaporization threshold might be unknown. One of the reasons is the decreasing of the particle refractive index function *E(m)* with particle size [1]. Due to this effect the particle heat up temperature couldn't reach the vaporization threshold at low fluences. Besides that, the vaporization temperature could decrease with particle size. The knowledge about particle vaporization process is useful not only for correct LII measurements, but also for the determination of particle thermodynamics properties changing due to size effect [2]. Direct characterization of vaporization process of soot was performed by simultaneous scattering and LII registration [3], by emission spectroscopy [4] and by two pulse lasers [5] in flames. The goal of this work is the application of laser light extinction measurements and Ti-Re LII for observation and analysis of vaporization process of small carbon and iron particles.

The carbon particles were formed in pyrolisis of 1% C_6H_6+Ar behind reflected shock wave. Two-color Ti-Re LII technique was applied for particle heat up temperature and size measurements at fluencies around 0.4 J/cm^2. He-Ne laser beam was adjusted coaxially to the YAG (1064 nm) laser beam and allowed to observe the decreasing of a volume of condensed phase due to vaporization. Additionally, the real particle temperature equilibrated with bath gas during pyrolisis process was measured by emission-absorption spectroscopy in visible range of spectra. The measured gas-particle temperature was less than frozen temperature behind shock wave due to endothermic effect of C_6H_6 decomposition. The vaporization temperature of small growing carbon particles with mean diameters of 2-14 nm was found to be in the range of 2900-3100 K in contrast to soot vaporization temperature 4000 K [6].

Growing iron particles of different sizes (2-11 nm), synthesized in the laser photolysis reactor [1], were heated by YAG laser pulse with fluences of 0.025-0.7 J/cm^2. The same technique as for carbon particles was used for condensed phase loss, temperature and size measurements. The essential difference of iron particles vaporization temperature (2100-2700 K) from the bulk one (about 3050 K) in dependence on particle size and pressure of a bath gas was found.

The dispersion of vaporization temperature observed in both experiments is probably caused by with the variation of particle properties formed at different conditions. The related value of evaporated fraction of condensed phase and particle vaporization temperature are analyzed in dependence on experimental conditions.

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