Particle size measurements with two color TIRE-LII

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Two-color TIRE-LII was applied for the sizing of soot particles. The experiments were performed in a premixed ethylene/air flame burning on a sintered stainless steel plug (McKenna) burner with equivalence ratios (ϕ) of 2.0 to 2.6 at a height above the burner of 12 mm. The flame was stabilized with a 20 mm thick steel plate with a diameter of 60 mm which was fixed 21 mm above the burner surface (HAB).

Introduction

The aim of this investigation is to more assess the performance of the LII model by comparing the results obtained simultaneously at two different detection wavelengths. The data will be useful for the further development of soot-formation model.

LII Model and Experiments

The LII model described in Ref. [1] was used in this study by adjusting the mass accommodation coefficient α_M from 0.8 to the value of 0.5 [2] in addition to the assumption of a constant value (0.261) for the refractive index absorption function *E(m)* [3]. We have validated this model with the experimental measurements of time resolved LII in a laminar ethene diffusion flame obtained at several laser fluences [4], see Fig. 1.

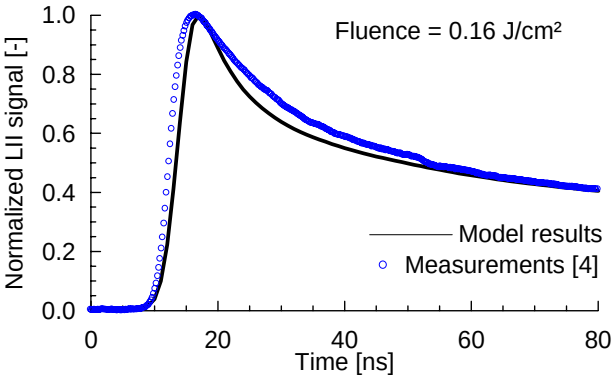

Fig. 1: LII signal for a 35-nm particle at 1900 K.

Results

The LII signal excited by a single Nd:YAG laser pulse (1064 nm, 0.11 J/cm^2) is observed at two detection wavelengths: 400±8nm and 700±21nm. For either measurement, 300 signals were averaged in order to reduce noise, and an average signal without laser irradiance was subtracted in order to account for the natural flame luminosity. Normalized model LII signals over the complete temporal range for different initial particle diameters are fitted to the measured one until the best fit is attained. An example of the measured LII signal fitted to the calculated signal is shown in Fig. 2.

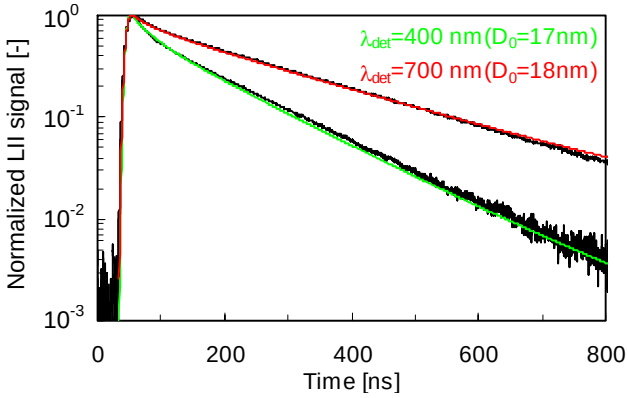

Fig. 2: Normalized LII signal as function of time, Experiment (ϕ=2.30) and calculated for T_g=1700 K, at two different detection wavelengths.

Fig. 3 shows that the obtained sizes at two different detection wavelengths are nearly identical.

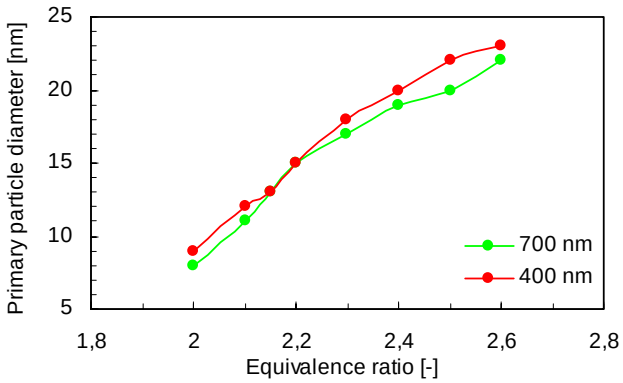

Fig. 3: Soot particle size measured by TIRE-LII as a function of ϕ at 12 mm HAB in the flame.

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