Cavity Ringdown Spectroscopy In Ns Pulsed Discharges

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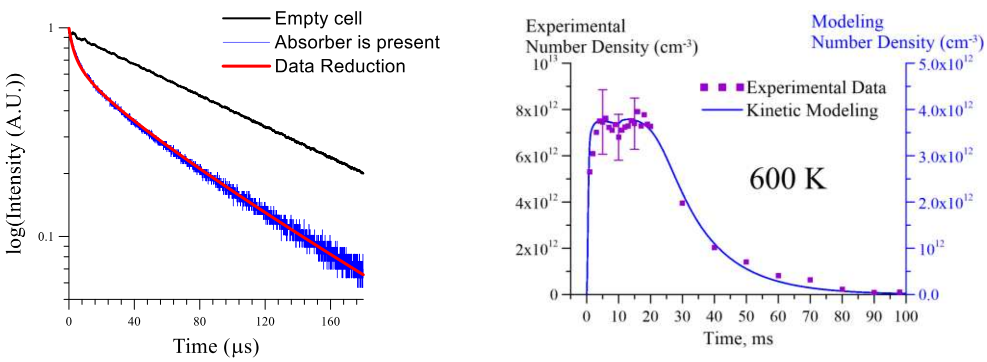
In recent years, ns pulsed discharges have become the subject of numerous studies for biomedical applications, fuel reforming, plasma-assisted combustion, nitrogen fixation, and beyond [1]. Although remarkable progress has been made in understanding the fundamental physics that occur in these low temperature nonequilibrium plasmas, many challenges still persist such as the chemical kinetics and reaction pathways of the plasma radicals [2]. In order to understand the driving mechanisms and key parameters of these plasmas, time-resolved absolute concentrations of the generated radicals must be measured. The most direct and reliable measurement of obtaining absolute radical concentrations is with absorption spectroscopy. With the lowest detection limit for absorption spectroscopy, cavity ringdown spectroscopy (CRDS) is a promising technique for measuring radicals in ns plasma discharges.

This talk will discuss the fundamentals of CRDS, the pros and cons of implementation in ns pulsed discharges, and recent CRDS measurements in a variety of different ns plasma systems [3-5]. The presentation will discuss implementation of pulsed CRDS and the effect of laser linewidth on the ringdown decay signal as shown in Fig. 1(a). The discussion will also include measurements taken in a repetitive, ns pulse, double dielectric barrier discharge plasmas of the excited metastable state of molecular nitrogen, $N_2(A^3\Sigma^+_u)$ and the low-temperature hydroperoxyl radical, HO_2, generated in a preheated plasma flow reactor as shown in Fig. 1(b).



(a) (b)

Figure 1. (a) Typical cavity ringdown traces for: (1) an empty cell, (2) when an absorber is present in the cell with an absorption lineshape on the order of the laser linewidth, and (3) obtained from data reduction. (b) Comparison of experimental CRDS HO_2 number density obtained in a 2% H_2 – 2% O_2 – 96% Ar plasma and afterglow, initially at T = 600 K to modeling predictions.

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