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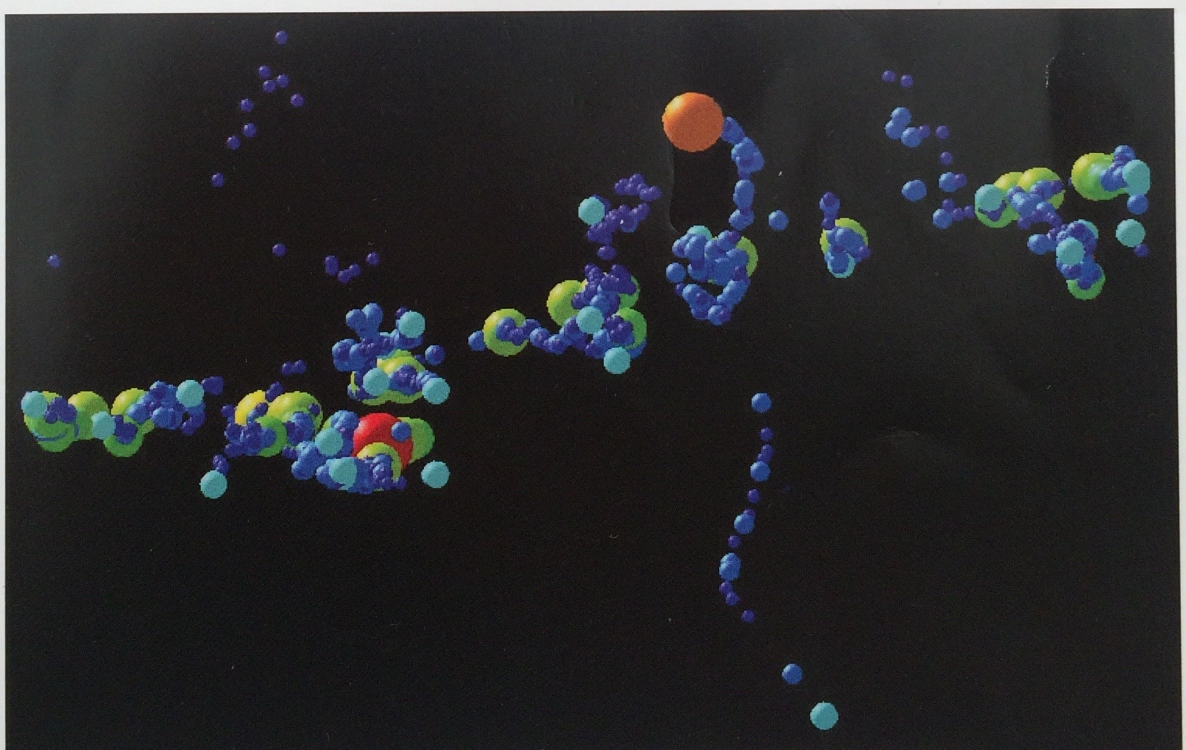

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APS physics

SESSION NR4: PLASMA-ASSISTED COMBUSTION
Thursday Morning, 15 October 2015
Room: 303 AB at 8:00
Shinji Kambara, Gifu University, presiding

Contributed Papers

8:00

NR4 1 Nanosecond-gated laser induced breakdown spectroscopy in hydrocarbon mixtures KAZUNOBU KOBAYASHI, *Osaka Gas Co., Ltd., University of Notre Dame* MOON SOO BAK, *Sungkyunkwan University* HIROKI TANAKA, *Osaka Gas Co., Ltd.* HYUNGROK DO, *Seoul National University, University of Notre Dame* Nanosecond-gated laser induced breakdown spectroscopy have been carried out in four different hydrocarbon gas mixtures (CH4/CO2/O2/N2, C2H4/O2/N2, C3H8/CO2/O2/N2 and C4H10/CO2/O2/N2) to investigate the effect of gas species on the laser induced breakdown kinetics and resulting the plasma emission. For this purpose, each mixture that consists of different species has the same atom composition. It is found that the temporal emission spectra and the decay rates of atomic line-intensities are almost identical for the breakdowns in the four different mixtures. This finding may indicate that the breakdown plasmas of these mixtures reach a similar thermodynamic and physiochemical state after its formation, resulting in a similar trend of quenching of excited species.

8:15

NR4 2 Response of a laminar M-shaped premixed flame to plasma forcing DEANNA A. LACOSTE, *King Abdullah University of Science and Technology* JONAS P. MOECK, *Technische Universität Berlin* MIN SUK CHA, SUK HO CHUNG, *King Abdullah University of Science and Technology* DRACO COLLABORATION We report on the response of a lean methane-air flame to non-thermal plasma forcing. The set-up consists of an axisymmetric burner, with a nozzle made of a quartz tube of 7-mm inlet diameter. The equivalence ratio is 0.9 and the flame is stabilized in an M-shape morphology over a central stainless steel rod and the quartz tube. The plasma is produced by nanosecond pulses of 10 kV maximum voltage amplitude, applied at 10 kHz. The central rod is used as a cathode, while the anode is a stainless steel ring, fixed on the outer surface of the quartz tube. The plasma forcing is produced by bursts of plasma pulses of 1 s duration. The response of the flame is investigated through the heat release rate (HRR) fluctuations. The chemiluminescence of CH* between two consecutive pulses was recorded using an intensified camera with an optical filter to estimate the HRR fluctuations. The results show that, even though the plasma is located in the combustion area, the flame is not responding to each single plasma pulse, but is affected by the discharge burst. The plasma forcing can then be considered as a step of forcing: the beginning of a positive step corresponding to the first plasma pulse, and the beginning of a negative step corresponding to the end of the last pulse of the burst. The effects of both positive and negative steps were investigated. The response of the flame is then analyzed and viable mechanisms are discussed.

8:30

NR4 3 Characteristics of 2-heptanone decomposition using nanosecond pulsed discharge plasma YUKI NAKASE, YUICHI FUKUCHI, DOUYAN WANG, TAKAO NAMIHIRA, HIDENORI AKIYAMA, *Kumamoto University* KUMAMOTO UNIVERSITY COLLABORATION Volatile organic compounds (VOC) evaporate at room temperature. VOCs typically consist of toluene, benzene and ethyl acetate, which are used in cosmetics, dry cleaning products and paints. Exposure to elevated levels of VOCs may cause headaches, dizziness and irritation to the eyes, nose, and throat; they may also cause environmental problems such as air pollution, acid rain and photochemical smog. As such, they require prompt removal. Nanosecond pulsed discharge is a kind of non-thermal plasma consisting of a streamer discharge. Several advantages of nanosecond pulsed discharge plasma have been demonstrated by studies of our research group, including low heat loss, highly energetic electron generation, and the production of highly active radicals. These advantages have shown ns pulsed discharge plasma capable of higher energy efficiency for processes, such as air purification, wastewater treatment and ozone generation. In this research, nanosecond pulsed discharge plasma was employed to treat 2-heptanone, which is a volatile organic compound type and presents several harmful effects. Characteristics of treatment dependent on applied voltage, gas flow rate and input energy density were investigated. Furthermore, byproducts generated by treatment were also investigated.

8:45

NR4 4 Importance of atomic oxygen in preheating zone in plasma-assisted combustion of a steady-state premixed burner flame K. ZAIMA, *Hokkaido University, Japan* H. AKASHI, *National Defense Academy, Japan* K. SASAKI, *Hokkaido University, Japan* It is widely believed that electron impact processes play essential roles in plasma-assisted combustion. However, the concrete roles of high-energy electrons have not been fully understood yet. In this work, we examined the density of atomic oxygen in a premixed burner flame with the superposition of dielectric barrier discharge (DBD). The density of atomic oxygen in the reaction zone was not affected by the superposition of DBD, indicating that the amount of atomic oxygen produced by combustion reactions was much larger than that produced by electron impact processes. On the other hand, in the preheating zone, we observed high-frequency oscillation of the density of atomic oxygen at the timings of the pulsed current of DBD. The oscillation suggests the rapid consumption of additional atomic oxygen by combustion reactions. A numerical simulation using Chemkin indicates the shortened ignition delay time when adding additional atomic oxygen in the period of low-temperature oxidation. The present results reveals the importance of atomic oxygen, which is produced by the effect of high-energy electrons, in the preheating zone in plasma-assisted combustion of the steady-state premixed burner flame.

9:00

NR4 5 Plasma Torch for Plasma Ignition and Combustion of Coal ALEXANDR USTIMENKO, *R&D Plasmotechnics* VLADIMIR MESSERLE, *Retired* Plasma-fuel systems (PFS) have been developed to improve coal combustion efficiency. PFS is a pulverized coal burner equipped with arc plasma torch producing high temperature air stream of 4000 – 6000 K. Plasma activation of coal at the PFS increases the coal reactivity and provides more effective ignition and ecologically friendly incineration of low-rank coal. The main and crucial element of PFS is plasma torch. Simplicity and reliability of the industrial arc plasma torches using cylindrical copper cathode and air as plasma forming gas predestined their application at heat and power engineering for plasma aided coal combustion. Life time of these plasma torches electrodes is critical and usually limited to 200 hours. Considered in this report direct current arc plasma torch has the cathode life significantly exceeded 1000 hours. To ensure the electrodes long life the process of hydrocarbon gas dissociation in the electric arc discharge is used. In accordance to this method atoms and ions of carbon from