NO_2 production in a dielectric barrier discharge in air-CH_4 mixtures

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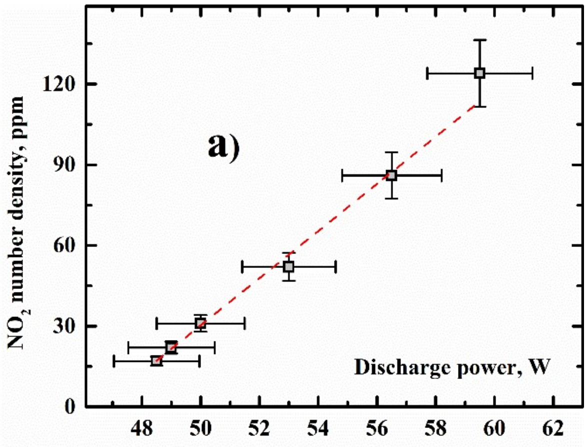
Dielectric barrier discharge (DBD) is of particular interest in the field of accelerating chemical processes in lean fuel-air mixtures and plasma stabilization of combustion due to the relative simplicity of technical implementation and the ability to be easily integrated into various gas flow configurations [1,2]. To develop and verify the existing kinetic models of DBD plasma-associated combustion, all possible experimental data on the composition of the gas mixture in the discharge afterglow are required.

Figure 1(a) shows measured number densities of NO_2 in the afterglow of DBD as a function of power input at a constant pressure 1 atm and air flow rate 4 L/min in the absence of methane. The DBD system used in the experiments is described in detail in [3]. NO_2 number densities were measured using tunable diode-laser absorption spectroscopy at a wavelength near 404.3 nm. It was found that nitrogen dioxide was present in the afterglow of the barrier discharge only when a certain threshold value of the discharge power was exceeded, and then NO_2 number density increased linearly with power. The value of the nitrogen dioxide production threshold in the barrier discharge was determined to be 46.5 ± 0.5 W using the linear approximation of the experimentally obtained data. The measured threshold value corresponds to an energy input into the gas of 580 ± 6 J/g.



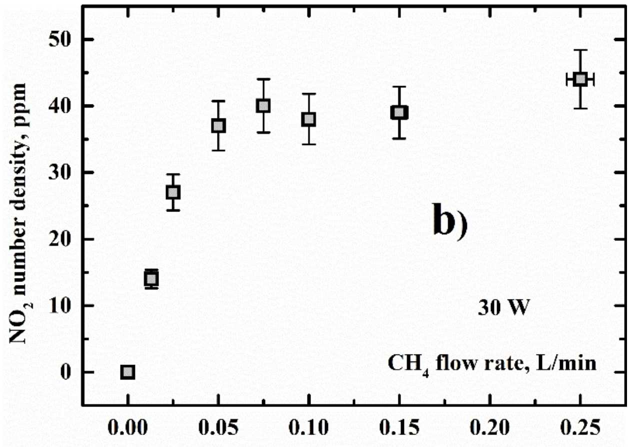


Figure 1. The measured number densities of NO_2 in the DBD afterglow at constant pressure 1 atm and air flow rate 4 L/min as a function of: (a) discharge power W; (b) CH_4 flow rate.

Figure 1(b) shows the dependence of the NO_2 number densities in the DBD afterglow on the methane flow rate at a constant air flow rate 4 L/min for a discharge power input equal to 30 W, which was below the NO_2 production threshold. However, nitrogen dioxide was observed in the discharge afterglow with the slightest addition of methane into the mixture (0.3%) and reaches a plateau at a 2.5% content of CH_4 in the air.

References

1. M. Dong et al. *Energy.* **2020**, 199, 117463.
2. Chen Y. et al. *Aerospace Science and Technology.* **2020,** 99, 105765.
3. Mikheyev P. A. et al. *Plasma Sources Science and Technology.* **2020,** 29, 015012.