Threshold intensities for laser spark in pure O_2, N_2 and CH_4

Nikolay Khvatov[1], Aleksei Torbin[1,2], Iakov Medvedkov[1,2]

[1] Lebedev Physical Institute, Samara Branch, 221 Novo-Sadovaya str., Samara, Russia, 443011
[2] Samara National Research University, 34, Moskovskoye shosse, Samara, Russia, 443086
torbin.ap@yandex.ru

The laser impact on combustible mixtures is one of the possible ways to initiate chain reactions [1-3]. This is especially relevant now, when the initiation of combustion must be carried out under conditions of high pressures, fast compression rates and lean fuel mixtures. Initiation by a laser spark has a number of advantages over traditional methods: ease in management of time and place of ignition, absence of electrodes, the possibility of implementing multi-point ignition, etc.

In the present study, we performed measurements of threshold intensities for laser spark in the air/CH_4 mixture at different pressures. Laser radiation was provided by a tunable dye laser Sirah Precision Scan PSCAN-D-18-EG pumped by the second harmonic of a Nd:YAG laser Quanta-Ray PR0-290-10E. The dye laser was set at wavelength λ=761 nm. The laser spark was initiated in a 180 mm length quartz tube with an inner diameter of 8.5 mm, covered with nichrome thread, which allowed heating the gas up to 1000 K. The quartz tube was installed into the stainless steel chamber with two windows for input and output of the laser beam and a third one for visual observation of the spark. The experimentally obtained threshold intensities for laser spark on pressure of oxygen, nitrogen and methane are presented in Figure 1 at room temperature. The leftmost values in the figure indicate the minimum pressures at which a spark occurred. The slight wavelength variations in the range of 750–770 nm did not lead to noticeable changes. In addition, the high temperature experiments (up to 1000 K) in N_2 and O_2 did not reveal the dependencies of threshold intensity by temperature.

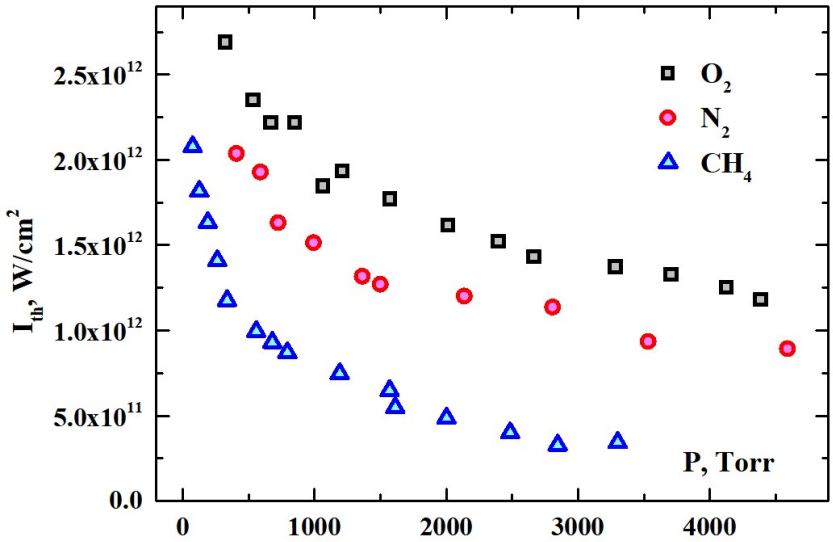

Figure 1 – Threshold intensities for laser spark in three gases at λ=761 nm and T=297 K

References

1. T.X. Phuoc. *Optics and Lasers in Engineering*. **2006**. 44(5). P. 351-397.
2. Y.E. Gamal et al. *Physics of Plasmas*. **2017**. 24(10). P. 103503.
3. T.Endo et al. *Combustion and Flame.* **2017**. 178. P. 1-6.