# ULTRA-LEAN AND ULTRA-RICH FLAMES STABILIZATION BY HIGH-VOLTAGE NANOSECOND PULSED DISCHARGE

A.A. Nikipelov
*Moscow institute of physics and technology, Russia*
*NEQLab Research BV, The Hague, The Netherlands*

I.B. Popov, G. Correale, A.E. Rakitin
*NEQLab Research BV, The Hague, The Netherlands*

and A.Yu. Starikovskii
*Drexel University, Philadelphia, PA*

Strict environmental regulations on emissions levels in combustion chambers of all kinds recently led to the development of various lean combustion concepts. One of the key problems in these systems is flame stabilization at equivalence ratii as low as 0.05—0.2. These conditions ensure very low NOx production rate, but at the same time require careful design of the burner, the combustion chamber and the flow pattern inside to provide stable flame attachment and combustion completeness.

One of the approaches for lean flame stabilization is the application of plasma–assisted burners, also referred to as plasmatrons. Mainly plasmatrons are based arc, spark, or microwave discharges, since they have been thoroughly studied and present relatively simple designs with low costs. The general problems of these approaches are significant energy consumption and short life cycles due to overheating and erosion of electrodes. The best examples provide 100 operating hours while the necessary life cycle is approximately 1000 hr for industrial applications. The concept of plasma–assisted combustion has been applied to develop an ignition and flame stabilizing system for a wide range of fuels, equivalence ratios, gas pressures, and temperatures. A series of plasmatrons based on repetitively pulsed nanosecond high–voltage discharge has been developed. The optimal configuration and discharge parameters for ultra–lean (ER>0.03) and ultra–rich (ER<3.3) flame stabilization have been found experimentally. Air flow pattern has been modelled numerically to optimize the discharge–flow interaction. The plasmatrons demonstrate exceptional flame stability with an average discharge power less than 400 W for a total power of the burner higher than 10 kW.

* Work supported by AFOSR