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ATMOSPHERIC PRESSURE NON-THERMAL PLASMA: SOURCES AND APPLICATIONS

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Abstract. Non-thermal plasma at atmospheric pressure is an inherently unstable object. Nature of discharge plasma instabilities and conditions for observation of uniform non-thermal plasma at atmospheric pressure in different environments will be discussed. Various discharge techniques have been developed, which could support uniform non-thermal plasma with parameters varied in a wide range. Time limitation by plasma instabilities can be overcome by shortening pulse length or by restriction of plasma plug residence time with a fast gas flow. Discharge instabilities leading to formation of filaments or sparks are provoked by a positive feedback between the electric field and plasma density, while the counteracting process is plasma and thermal diffusion. With gas pressure growth the size of plasma fluctuation, which could be stabilized by diffusion, diminishes. As a result, to have long lived uniform plasma one should miniaturize discharge.

There exist a number of active methods to organize negative feedback between the electric field and plasma density in order to suppress or, at least, delay the instability. Among them are ballast resistors in combination with electrode sectioning, reactive ballast, electronic feedback, and dielectric barrier across the electric current. The last methods are relevant for ac discharges. In the lecture an overview will be given of different discharge techniques scalable in pressure up to one atmosphere.

The interest in this topic is dictated by a potential economic benefit from numerous non-thermal plasma technologies. The spectrum of non-thermal plasma applications is continuously broadening. An incomplete list of known applications includes: plasma-assisted chemical vapor deposition, etching, polymerization, gas-phase synthesis, protective coating deposition, toxic and harmful gas decomposition, destruction of warfare agents, electromagnetic wave shielding, polymer surface modifications, gas laser excitation, odor control, plasma assisted combustion, and gas dynamic flow control. Many of these applications have been developed with low-pressure plasma. Atmospheric pressure non-thermal plasma technologies possess such advantages as simplicity of operation and relatively low cost of equipments. A variety of available discharge techniques provides non-thermal plasma at atmospheric pressure in various gases with parameters covering a wide range in power densities, reduced electric field strengths and current densities. Requirements to non-thermal plasma parameters and sorts of gas for various applications vary widely, too. For any specific application the most appropriate discharge type can be found. The spectrum of discharge devices already existing is surprisingly broad. The problem of a successful choice of a discharge type for a specific application will be discussed. A particular emphasis will be placed on the problem of plasma removal of toxic and harmful species from the gas flow.