SURFACE BARRIER DISCHARGE EVOLUTION in AIR and NITROGEN: ROLE of NEGATIVE IONS

Sergey Leonov
JIHT RAS, Izhorskaya st 13 bld2, Moscow, 125412, Russia

Richard Miles, Dmitry Opaits
Princeton University, NJ 08540 USA

Victor Soloviev
MIPT, Dolgoprudnyi, Moscow region, 141700, Russia

Last time numerous papers concern the boundary layer (BL) actuation by surface dielectric barrier discharge (SDBD) [1-3]. These discharges directly act on gas momentum through the mechanism of charge separation. Another mechanism of BL separation control by SDBD is increasing the flow stability through an addition of disturbances to the BL at particular frequency. In the most cases an average magnitude of the plasma-induced velocity is rather small for high-speed flow control. The objective of this work is to make clearer the physical mechanism of plasma-flow interaction and, finally, to maximize the local and instant amplitude of plasma effect. Among the others two problems are still discussable: exact spatial/temporal distribution of plasma-related force, and specific role of negative ions in a net force budget.

The experiments were made in conventional nonsymmetrical electrodes configuration of SDBD at voltage amplitude U?12kV, sinusoidal waveform, frequency f=0.02- 2kHz. Diagnostic included electrical measurements, timeresolved Pitot tube pressure measurements, and triggered short shutter intensified CCD camera visualization. Measurements were made in air and nitrogen at atmospheric pressure.

Three main features of SDBD behavior in air and nitrogen were observed. First, for a voltage half cycle corresponding to a positive potential of exposed electrode the discharge has a qualitatively the same streamer form both in air and in nitrogen. In this case the SDBD produced body force is rather small to be registered by used sensor. Second, for a negative potential of exposed electrode the discharge has a diffused form both in air and nitrogen with high intensity illumination from the cathode layer region adjacent to exposed electrode. In addition to this luminosity the discharge evolution in nitrogen is accompanied by radiation from the moving region, corresponding to the front of electron cloud seeding the dielectric surface. No such type of radiation is seen for SDBD evolution in air. Third, in the case of a negative potential of exposed electrode the SDBD produced body force is valuable in air and small to be seen in nitrogen. To explain the aforementioned features of SDBD behavior in air and nitrogen the results of numerical simulation [2] have been used.

1 Corke T.C., Post M.L., Orlov D.M. // *Exp Fluids* (2009) 46:1–26

2. Soloviev V.R., Krivtsov V.M. // *J. Phys. D: Appl. Phys*. **42** (2009) 125208 (13pp).

3. Opaits D., Likhanskii A., Edwards M., Zaidi S., Shneider M., Macheret S., Miles R. //*Paper AIAA-2010-0469.*