Ionic wind produced by corona discharges and dielectric barrier discharges in atmospheric air

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A corona discharge can be generated in air at atmospheric pressure when a sufficient high voltage is applied at a thin active electrode. The ions produced around the thin electrode are subjected to the Coulomb force, and therefore move towards the grounded electrode; on their path, they exchange momentum with the surrounding air neutral molecules by collisions, thus producing the movement of the whole fluid, such as a jet, from the high voltage electrode towards the collecting electrode. This flow is called "ionic wind" and can reach about 10 m/s. This phenomenon can be used as an electromechanical actuator without moving parts, which directly converts electrical energy into a flow *i.e.* mechanical energy. In this case, we speak of plasma actuators. For instance, Figure 1a presents an instantaneous velocity field of the ionic wind produced by a *volume* corona discharge between a needle and a plate. Furthermore, since the early 2000s, lots of research teams have been investigating the ability of *surface* corona-type discharges to modify boundary layer near-wall flow for the control of subsonic airflows. In aeronautical applications, the aim can be for instance to reduce skin-friction drag. The most common plasma actuator is based on a surface dielectric barrier discharge (DBD) that is established between an air-exposed high voltage electrode and a grounded electrode encapsulated inside a dielectric material (Figure 1b). The main advantage of plasma actuators is that one can imagine any electrode geometry (Figure 1c), the control strategies being then infinite, and this for a large number of industrial applications for which fluid mechanics are involved. During the oral presentation, we will discuss of the dynamic properties of the produced ionic wind and how it can be used in different applications.

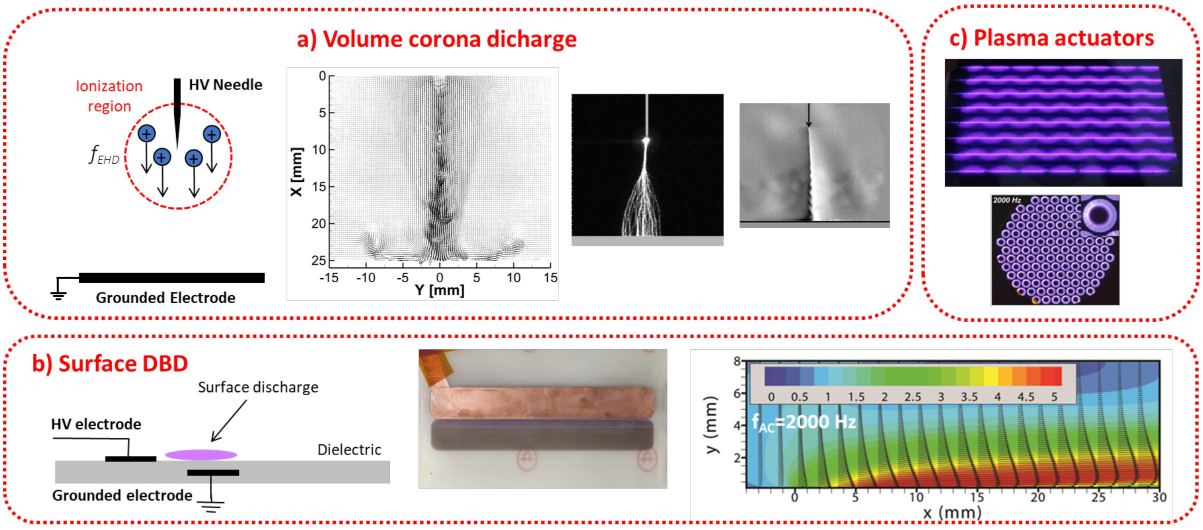

Figure 1. Plasma actuators: a) schema of a volume corona discharge, with a needle-to-plate geometry, instantaneous flow field of the ionic wind produced between a needle and a plate obtained by PIV (the needle tip is located at (x = 0, y = 0), iCCD visualization of the discharge streamers and visualization of the ionic wind by strioscopy. b) side-view of a surface dielectric barrier discharge (DBD), photo of the electrodes of a surface DBD and flow vector field of the ionic wind wall-jet produced by a surface DBD. c) original designs of surface plasma actuators.