

# Nanosecond Surface Dielectric Barrier Discharge: Experimental studies of streamer to filament transition in high-pressure gases

**V. Lafaurie<sup>1</sup>, S. Starikovskaia<sup>1</sup>**

*Laboratory of Plasma Physics, UMR764, Ecole Polytechnique, Palaiseau, France<sup>1</sup>*

A common feature of high-pressure nSDBD is the two different discharge propagation modes that exist depending on the pressure and applied voltage, referred to here as the diffuse/streamer mode and the filament mode. For a fixed pressure, the diffuse/streamer mode with a diameter of roughly 200-300 $\mu\text{m}$  is usually observed at lower applied voltages. With increasing voltage, filaments of roughly 20 $\mu\text{m}$  channels appear for every 4 or 5 diffuse streamer observed. This transition is abrupt, typically taking 1 to 2 ns, and accompanied with a sharp rise of electron density from  $10^{15}\text{ cm}^{-3}$  to  $10^{19}\text{ cm}^{-3}$ . A transition point was defined as the voltage for which formation of 2 to 5 filaments is observed in the first 12 ns of the discharge [1,2].

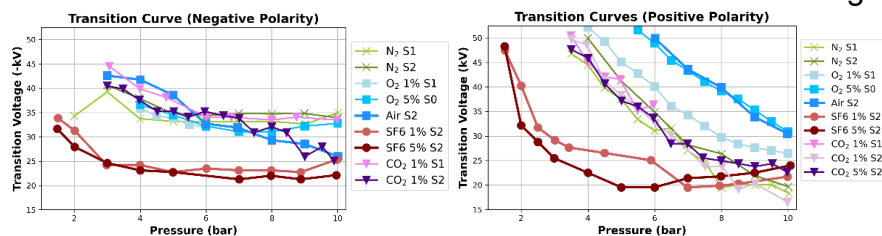


Figure 2: Transition curves in positive and negative polarities for different gas compositions

In the positive polarity, the variation of the transition threshold with gas composition is large. Using  $\text{N}_2$  as the reference, the addition of fractions of  $\text{O}_2$  to the mixture appears to increase the transition voltage for a given pressure. This can be attributed to photoionisation of the  $\text{O}_2$  by electronically excited  $\text{N}_2$  [3]. Indeed, in  $\text{N}_2:\text{O}_2$  mixtures ionization of  $\text{O}_2$  molecules occurs due to the absorption of the emission produced by highly excited  $\text{N}_2$  and  $\text{N}$ -atoms, both produced by direct electron impact [5,6]. For comparison, measurements with  $\text{CO}_2$  fractions cannot be differentiated from  $\text{N}_2$  transition. At the negative polarity, all curves for  $\text{N}_2:\text{O}_2$  mixtures and  $\text{CO}_2$  are collapsed together.

Finally, looking at the highest possible electronegativity, that is at the  $\text{SF}_6$  fractions, the transition voltage is noticeably lower than all other mixtures. It is of importance to note that in the highest pressures in both polarities, the  $\text{SF}_6$  discharges are immediately in filamentary mode, no diffuse mode existing and no discharge lighting before the transition. The trend of transition is somewhat maintained although shifted left, and the addition of even 1% of  $\text{SF}_6$  is sufficient to still transition at pressures where, in pure  $\text{N}_2$ , it would be impossible to get a filament.

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## References

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