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Plasma streamer propagation dynamics in gas phase DBD, catalyst pores and SDBD

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Atmospheric-pressure dielectric barrier discharges (DBD) hold significant potential in biomedical, catalytic, and environmental applications. However, the propagation mechanism and the interactions between plasma streamers and dielectrics/catalysts are rather complicated and still far from understood. On one hand, depending on the polarity of applied voltage, either a negative or positive streamer can be generated, and their propagation behaviors and interactions with material surface are completely different; On the other hand, the discharge structure/geometry could be very different, including gas phase, packed Dielectric-barrier discharge (DBD) with catalysts, internal space in structure catalysts and surface DBD (SDBD). Both the ignition and propagation behaviors of plasma streamers are very different from each other.

This study integrates experimental diagnostics and numerical modeling to systematically investigate streamer dynamics in DBD/SDBD systems. It reveals how surface charging, catalyst geometry, dielectric coating, voltage waveform induce localized electric field distortions, thereby regulating streamer pathways (as seen in figure 1) and energy distribution.[1] The established "geometric structure – field distortion – streamer evolution" framework advances the understanding of plasma-catalyst interactions and provides theoretical guidance for optimizing plasma devices in catalysis, surface modification, and flow control.

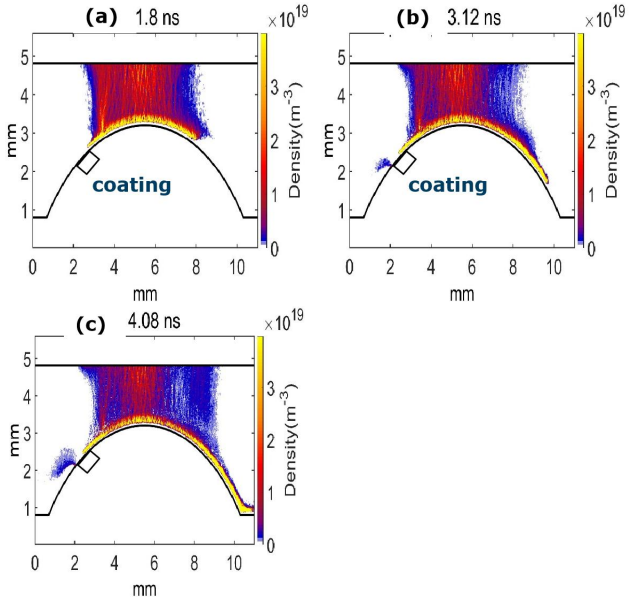

Figure1. Electron density distributions at different times (a-c) in the presence of a high k dielectric coating on the left side of the pellet

References

[1] L. Y. Zhang et al. Plasma Sources Sci. Technol. 33 (2024) 105016