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Study on characteristics of droplet-covered annular surface dielectric barrier discharge excited by microsecond pulse

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Surface dielectric barrier discharge (SDBD), as a crucial approach for generating low - temperature plasma, has the characteristics of simple structure, uniform stability, and high efficiency. In practical applications, the dielectric surface of SDBD exciter may be covered by droplets. This phenomenon will change the electric field distribution above the surface, thereby will influence the discharge performance. This article conducts experimental research on the discharge characteristics of annular SDBD under the excitation of microsecond pulses, and the dielectric surface of SDBD exciter is covered by droplets. Additionally, we build a three - dimensional simulation model to analyze the electric field distribution above the dielectric surface of the annular SDBD exciter and the impact of droplets on the electric field distribution.

Firstly, this article conducts discharge experiments on the annular SDBD exciter which dielectric surface is covered by a single water droplet. The results reveal that the discharge channel initiate from the inner side of the high voltage electrode tends to approach the water droplet as it develop towards the ground electrode. When the discharge channel develop to the water droplet, it will be divided into two stages. Through combine simulation analysis, it is found that the water droplet affects the accumulation process of charges on the dielectric surface. Water droplets influence the development process of the discharge channel by changing the electric field in the air gap space, playing a role similar to a "secondary electrode" and increasing the length and range of the discharge channel.

Subsequently, this article conducts discharge experiments on the annular SDBD exciter which dielectric surface is covered by droplets of different conductivity. Research has found that as the conductivity of droplets increased, the amplitude of discharge current increased, the initiation voltage of discharge decreased, and the discharge channels became brighter. However, the overall uniformity of the discharge decreased. When the conductivity of droplets is relatively low, the overall discharge distribution pattern of SDBD is mainly exhibits the discrete and diffuse mixed mode. When the conductivity of droplets is relatively high, the discharge distribution pattern of SDBD is mainly exhibits the discrete mode. This is because droplets with higher conductivity contain more free ions. Under the influence of the external electric field, polarization is more likely to occur at the three - phase interface. There are more freely moving charges on the dielectric surface and around the droplets, resulting in a larger gap electric field between the high voltage electrode and the droplets. Consequently, the discharge is more likely to initiate, and by concentrating the discharge channels around the droplets, the discharge intensity is enhanced, while the overall uniformity of the discharge is reduced.

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References

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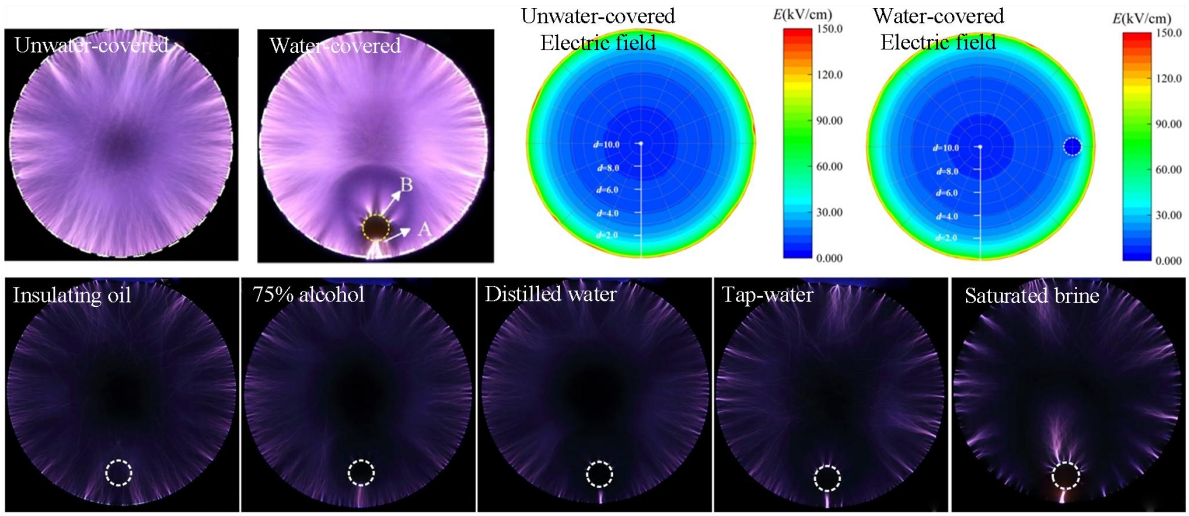

Figure 1. Discharge images and electric fields distribution of unwater / water-covered annular SDBD. And discharge images of annular SDBD covered by droplets of different conductivity