HOMOGENOUS DIELECTRIC BARRIER DISCHARG E IN NITROGEN AT ATMOSPHERIC PRESSURE

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A homogenous dielectric barrier discharge in nitrogen at atmospheric pressure was produced and identified with Townsend discharge. With the nitrogen flowing at a speed higher than 7 cm/s through a gap not longer than 3 mm, a stable Townsend discharge was always obtained. For a 2-mm nitrogen gap, the Townsend discharge was generated in a limited range of the applied voltage, from $V_{\rm min}$ to $V_{\rm max}$. While $V_{\rm min}$ keeps almost unchanged at a value of about 9.75 kV, $V_{\rm max}$ decreases from 12.4 kV to 9.75 kV as the frequency of the applied voltage increases from 1.5 kHz to 7 kHz. When the flow rate increases from 0 to 140 cm/s, the discharge current decreases from 3 mA to 2.5 mA and the breakdown voltage of the nitrogen gap increases from 5.3 kV to 5.9 kV, which is attributed to the nitrogen pressure in the gap rising up with the flow rate. The release of the trapped electrons from the dielectric surface plays an important role not only in the initiation of the Townsend discharge but also in the extinction of the discharge. The metastables $N_2(A^3\Sigma_u^+)$ impacting on the dielectric surface release sufficient primary seed electrons for the nitrogen gap to be broken down at the Townsend breakdown voltage, a much lower voltage than the streamer breakdown voltage, which is necessary for getting a Townsend discharge rather than a filamentary streamer discharge. With the nitrogen flow, the density of the impurity oxygen is much reduced in the discharge gap, which allows much more $N_2(A^3\Sigma_u^+)$ to survive to the time of the succeeding discharge for initiating a Townsend breakdown. It was found that the discharge is extinguished while $V_{\rm gas}$ continues rising up. The extraordinary distinction of the Townsend discharge could be explained with the limited number of the trapped electrons that could not provide the long-time lasting Townsend discharge with sufficient secondary electrons.

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