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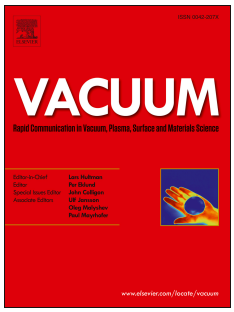

Positive streamer in gases: Physical approach from low to high energies

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Positive Streamer in Gases: Physical Approach from Low to High Energies

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***Abstract*—Approach to the breakdown theory in gases based on an energy basis has been presented. The minimum stressed volume zone (MSVZ) has been used as a concept to deal with the positive streamer process in gases. These processes start at low energy values under critical electric field (E_{cr}) of 4.5 kV/cm. In this MSVZ, several filament streamers spread within it with a minimum streamer filament radius (MSFR) $30\ \mu m$ (nearly about 400 filaments). Under E_{cr}, an associative detachment mechanism in these filaments starts. This detachment of electrons has occurred between O_2^- and O_2 which leading to increase the number of electrons inside the filaments. Also, the temperature increases inside the filaments due to the exothermic reaction of O^- and N_2. Furthermore, increases of the temperature occurred due to the collision inside these filaments. Consequently, the filament radius enlarges too within MSVZ with a value of $120\ \mu m$. This will cover the entire MSVZ with 25 filaments instead of 400 which has been considered as a new breakdown index in gases (n). Therefore, a new breakdown equation has been introduced relating energy, temperature, electric field, streamer velocity, and streamer radius with index n. At low energy level, the streamer radius changes with the stressed electrode diameter, applied field and temperature changes inside the filament till it reaches nearly $7500\ K$. However, under high energy level when the ionized species inside filaments increase, a main ionized streamer path (leader) emanates from the MSVZ toward the opposite electrode. The increased ionized species convert the medium inside this leader streamer stem to plasma state with high temperature $\cong 20000\ K$. Under arc condition, the leader streamer radius**