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Voltage-Potential Profiles of Glow Discharges Using an Emissive Probe

Voltage-potential profiles through glow discharge regions produced in a glass vacuum tube ~1 m long with a cathode and anode 46 cm apart under various pressures—12, 36.5, and 113 mTorr—are characterized by an emissive probe to better understand electron and ion kinetics of each region. Currently, there is a lack of published measurements beyond illustrations. A voltage of -800 V was applied to the cathode through a resistor of 12 kOhm. A large potential drop occurs in the cathode dark space due to the formation of a cathode sheath which causes electrons to be shielded from the cathode surface while ions strike the cathode with high energies causing secondary electrons to be emitted. These secondary electrons cause ionization forming the negative glow and are then reaccelerated by a weak electric field in the Faraday dark space. Through the negative glow and Faraday dark space, the potential reaches a plateau. In the positive column, stair-step like multiple double layers correlated with the light/dark striations. Electrons lose almost all of their energy due to ionization and are reaccelerated to ionization energy between striations by these double layers. The potential step in each dark band is approximately 13 eV—the ionization energy for N2 and O2. As the neutral pressure increases, the electron-neutral mean free path decreases resulting in thinner striations and double layers. At high enough pressure, the striations of the positive column merge toward fully illuminating the entire positive column corresponding to a linearly increasing potential ramp toward the anode.