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Influences of electron-electron and metastable collisions in electrical breakdown of air JOHN LOWKE, EUGENE TAM, ANTHONY MURPHY, CSIRO-Manufacturing — To predict the time development of electrical breakdown in air accurately, detailed knowledge is required of the dominant ionization processes that occur between initial ionization, which requires an electric field of ~ 25 kV/cm at 1 bar, and the final arc stage, which can be maintained by electric fields of only ~ 20 V/cm. This paper discusses two collision processes which increase ionization by changing the energy distribution function of the electrons. At 5 kV/cm at 1 bar, there are effectively zero electrons at high enough energies to produce ionization, so the ionization coefficient is zero, largely due to the large energy losses of electrons exciting the many vibrational states of nitrogen. This situation is markedly changed by collision processes that make the energy distribution more Maxwellian, introducing more electrons at ionization energies. One such process is electron-electron collisions, which can dominate for high degrees of ionization of the air. It is shown that this process can increase streamer speeds and lengths about a factor of two. A second process is the presence of large populations of metastable states, for example of nitrogen vibrational states, which can increase electron energies by electrons de-exciting these states. But the electric field and discharge times need to be large enough to allow for the development of sufficient population densities of these states. The discharge development times appear to be not large enough to explain lightning initiation at low fields.

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