Topic number: 1

Temperature effects on the electron transport coefficients in humid air

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The present work has been motivated by the need of testing the cross section data sets of water, oxygen and nitrogen in order to model atmospheric discharges at temperatures higher and lower than ambient (298 K). Thus, we have started this study dealing with the measurement and future calculation the transport properties of electrons in humid air.

We have measured the electron drift velocity v_e, and the effective ionization coefficient $(\alpha-\eta)/N$ (α and η are the electron impact ionization and attachment coefficients, respectively), for humid air over a wide range of the density-normalized electric field from 2 to 200 Td (1 Td=10^{-17} V cm^2), and at temperatures of 298 and 343 K. A swarm technique has been used, with a pulsed Townsend apparatus [1].

The electron drift velocities in the mixture of 10% H_2O-air at the gas temperatures of 298 K and 343 K are shown plotted in Fig. 1 as a function of E/N. The most outstanding feature of these two curves is the drastic change in shape at low of E/N. While the 298 K curve displays a slight negative differential conductivity effect, which is not at all aparent either in pure water or in air, the 343 K curve shows no such effect at all. The reason for this may stem on the effects of the several inelastic processes (e.g. vibrational excitation), which are enhanced when the temperature of the buffer gas increases.

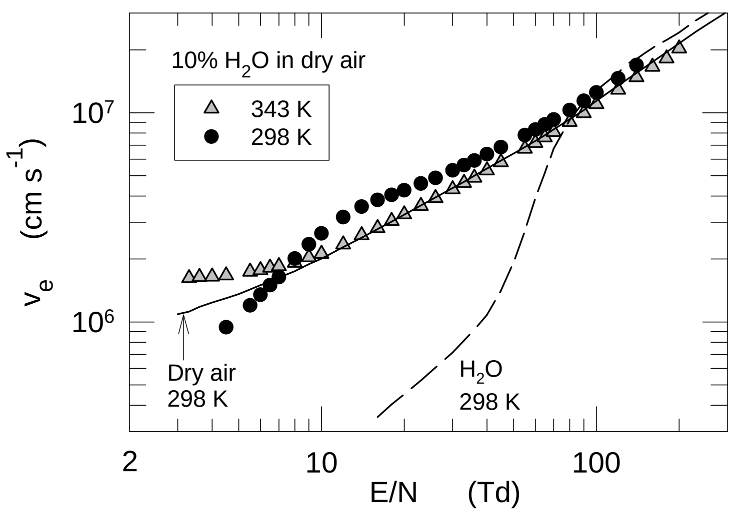

Figure. 1 The electron drift velocity v_e, in the mixtures 10% H_2O-air at the gas temperatures of 298 K (closed circles) and 343 K (gray triangles). For reference, the v_e curves (solid line) for dry air and H_2O (broken line) at 298 K have been added.

Figure 2 shows the density-normalized effective ionization coefficients $(\alpha-\eta)/N$, at temperatures of 298 K and 343 K. It is observed that the effects of a rise in temperature are reflected in a decrease of the attachment coefficient with respect with the mixture at 298 K, as it is seen from the E/N region between 50 Td and 90 Td. On the other hand, the marked lower trend of the 343 K curve for E/N>160 Td suggests that ionization processes also decrease. Other H_2O-dry air mixtures at 298 K have been studied and reported before [2]. It is interesting to note that the critical field strength (that value of E/N when $\alpha-\eta=0$) remains practically the same at around E/N=110 Td.

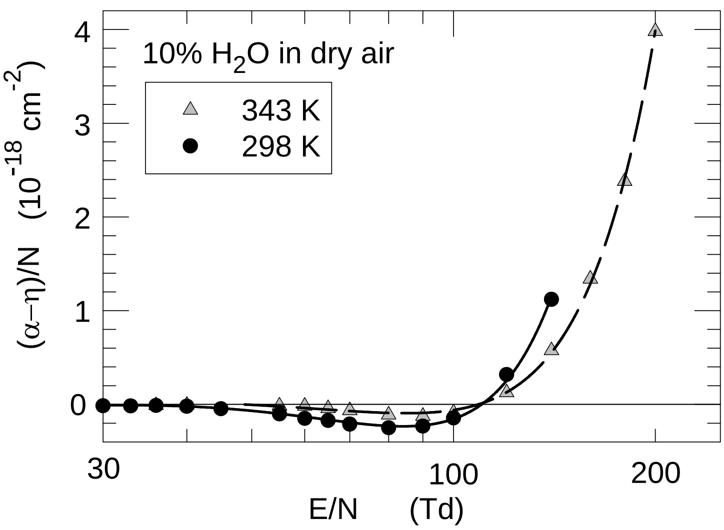

Figure 2. The density-normalized effective ionization coefficient in the mixtures 10% H_2O-air at the gas temperatures of 298 K (closed circles) and 343 K (gray triangles). The lines through the points serve the only purpose of guiding the eye.

Acknowledgements

This work has been partially supported by projects UNAM-PAPIIT IN 108508 (Mexico) and MICINN AYA2009-14027-C05-02 (Spain). G. Ruíz-Vargas is grateful to Conacyt for a PhD grant. Thanks are due to A. Bustos and R. Bustos for their technical assistance.

References

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