Topic number: 3

MEASUREMENT OF ELECTRON ATTACHMENT RATE TO O_2 USING ION MOBILITY SPECTROMETRY

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Introduction

Electron attachment rate to oxygen was measured in nitrogen/oxygen gas mixture at ambient pressure. The range of *E/n* varied from 0.5 to 2 Td and the content of O_2 in N_2/O_2 mixture was 0.1% to 2%. The rate constants for electron attachment were obtained using two different methods.

Experiment

The work was performed on a home made ion mobility spectrometer. Detailed descripton of the instrument is given in [1]. The electrons are obtained from a discharge in a point-to-plate geometry (negative potential applied to point electrode) fed by pure nitrogen. The discharge current has been found to be independent on presence of oxygen in the drift tube and it can be considered as a stable source of electrons. In both methods used electrons are released into drift tube in short pulses controlled by a shutter grid.

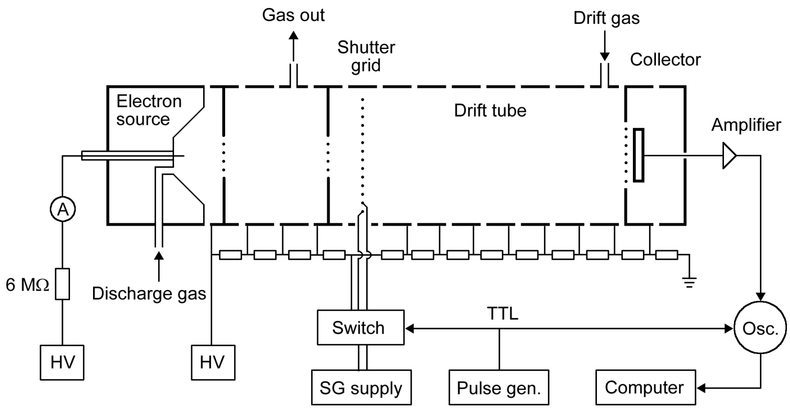

Fig. 1: The experimental setup.

The electrons drift under the action of electric field, some of them are captured and form negative ions, the rest reach collector at the end of drift tube. Electron attachment to O_2 in high pressure gas enviroment is a three body process. The speed of reaction can be expressed as

$$\frac{d[M^-]}{dt} = -\frac{d[e]}{dt} = k[M][e][X] \quad (1)$$

where k is the reaction rate constant. When no electron attachnig gas is present inside drift tube the current of electrons entering the drift tube I_0 can be measured on the collector. The current I_{Col} transmitted through drift tube containing O_2 allows to calculate the electron attachment rate

$$k = \frac{w_e}{L[O_2][X]} \ln \frac{I_0}{I_{Col}} \quad (2)$$

where L is the length of elecron-oxygen interaction path and w_e drift velocity of electrons.

The second method used in present study was priviously described in [2]. It allows to obtain the attachment rate constant from a single measurement. Electrons passing the drift tube produce a trace of negative ions with concentration proportional to amount of electrons passing the given location. The concentration of electrons $[e]_x$ decreases with increasing distance *d* from the shutter grid according to

$$[e]_x = [e]_0 \exp\left(-\frac{k[O_2][X]d}{w_e}\right) \quad (3)$$

Concentration profile of negative ions formed along the drift tube is mirrored on the oscilloscopic record of ion current arriving to collector shown on the Figure 3.

Results

Figure 2 shows electron attachment rate constants to O_2 obtained using both methods. Although the results obtained with different methods do not show perfect agreement, they are in rough agreement with previous study by Channin et al. [3] performed at low pressure. The reliability of present methods will be discussed.

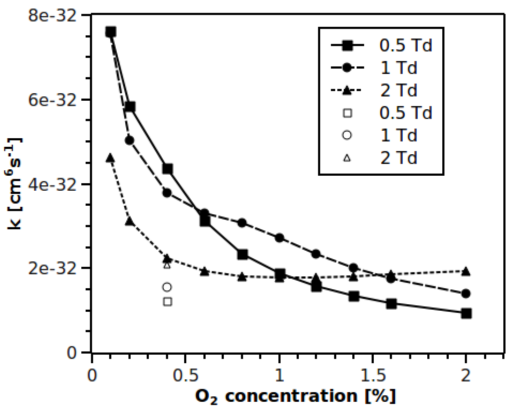

Fig. 2: Electron attachment rate constants to O_2 in N_2/O_2 mixture obtained using (2) (full symbols) and from negative ion concentration profile (empty symbols).

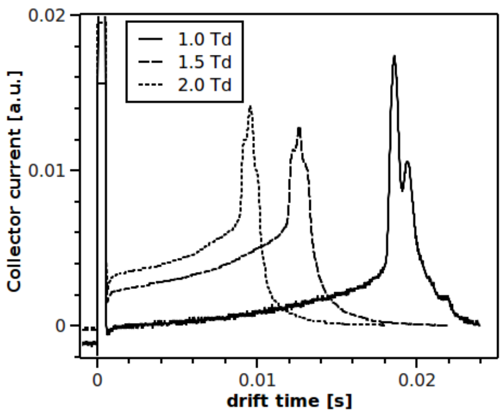

Fig.3: Oscilloscopic record of electron and ion current measured on collector. Intensities are adjusted to fit on the same scale.

Acknowledgement

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Reference

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[2] M. Tabrizchi, A. Abedi, *J. Phys. Chem. A* **108** (2004) 6319-6324
[3] L.M.Chanin, A.V.Phelps and M.A.Diondi, *Phys. Rev* **128** (1962) 219