A Low-temperature Windowless Absorption Cell Facility Preliminary Measurements of C_2H_2

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A new windowless absorption cell technique for gas phase cross-section measurements has been implemented and preliminary results of C_2H_2 in the spectral region between 146 and 154 nm have been obtained. The new apparatus will allow us to carry out measurements at temperatures lower than 140 K, previously achieved in our laboratory [1].

The advantage of using a windowless cell is that it is free from gas condensation occurring on the optical windows, which often takes place in a *closed* absorption cell system at temperatures lower than the melting point of the gas of interest. However, in a windowless cell it is necessary to accurately determine the effective path length (or the column density) in order to make accurate cross-section determinations. We have selected four major peaks of C_2H_2 at 147.8, 148.2, 149.8, and 151.9 nm, where the absorption cross-sections have been measured using a *closed* cell technique at 150 K [1] and 295 K [1,2]. The detailed calibration procedures for the effective path length of the windowless cell have recently been described [3]. In Fig. 1 we display the effective path lengths obtained for the four different wavelengths and two temperatures. From a linear fit we obtained a calibrated effective path length d=11.83(±0.08) cm. The effective path length appears to be insensitive to gas temperature at 151 and 296 K, with the C_2H_2 pressures operating in the range between 3 mTorr and 80 mTorr. This is understandable because the conditions at which the data obtained were well within the molecular flow regime.

We hace made use of the same effective path length to the determination of cross-sections at 139 and 130 K under the similar pressure conditions [3]. We plan to further test the validity in the case of CH_4. This is possible because the melting point for CH_4 is 90.5 K, and its pressure at 111.5 K is about one atmosphere, namely, 760 Torr. Therefore, we will be able to measure CH_4 cross-section values to temperatures at 110 K, and possibly lower. This study will allow us to support or repudiate the assertion that the effective absorption path length is relatively independent of temperature under the present operating pressure conditions. We will carry out this study in the near future.

From the result shown in Fig. 1 the calibrated effective path length is roughly constant between 296 K and 150 K. This suggests that the conductance of our open windowless orifice is roughly the same at both temperatures because the $T^{1/2}$ decrease is compensated for by the increasing sticking coefficient, S_{cT}. If we assume the sticking coefficient of C_2H_2 at 296 K is $S_{c296K} = 0$, we obtain a sticking coefficient value of $S_{c150K} = 0.32\pm0.02$ at 150 K. The detailed discussion has been given in Reference [3].

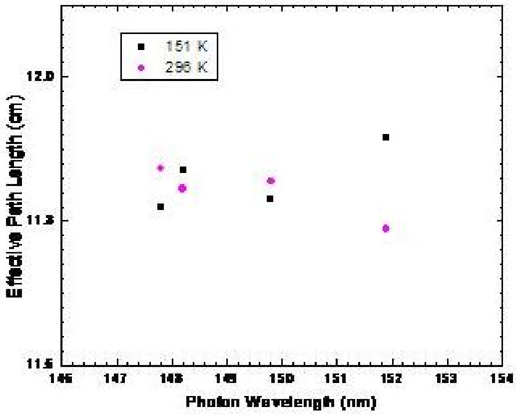

Fig. 1: The calibration results of the effective path length of the windowless absorption obtained by normalizing the cross-sections to those obtained with a closed window cell.

The data obtained will provide low-temperature absorption cross-sections of the solar system molecules, and thus determine temperature sensitive properties for diagnostic work on the atmospheres of outer planets, putting definitive constraints on the physical chemistry, radiative cooling, and atmospheric dynamics of Saturn and Titan.

References

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