RESOLUTION OF STRUCTURE IN ELECTRON ATTACHMENT IN NITROUS OXIDE BY A SIMPLE dc RETARDING TECHNIQUE*

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The phenomenon of electron attachment has been studied in some detail in nitrous oxide by means of a dc retarding-potential method, somewhat like that proposed by Briglia and Rapp.[1] A "total ionization tube" of the Tate and Smith type[2] was used with a rather large dc retarding potential applied to an accelerating plate in the electron beam preceding the ionization region, cutting off approximately 90% of the electrons used in the "normal" mode of operation. With this rather small electron current of 1.7×10^{-8} A it was still possible to study attachment in N_2O because of the rather large cross section in this gas. This electron-beam retardation decreased the electron-energy distribution sufficiently to observe two peaks in the attachment cross section. The results are in good agreement with those of Curran and Fox[3] obtained by a pulsed retarding potential difference method, showing a 30% dip between peaks, although the dip occurs at a slightly lower energy in the present work.

Figure 1 shows a plot of negative-ion current versus electron energy for two values of electron beam current, one in the "normal" operation mode, and the other in the "retarded" mode, described in the preceding paragraph. The curve taken in "normal" fashion is in good agreement with that of Rapp and Briglia.[4] The ordinates of the curve taken in the "retarded" mode have been adjusted so that the higher energy peak has the same ordinate as the higher energy peak in the "normal" mode. The calibration of the energy scale was obtained by taking electron retarding curves in each mode and establishing their linear extrapolations with the energy axis as zero energy. The pressure was roughly half a micron in both cases. The electron-energy distribution in the "retarded" mode is estimated to be less than 0.2 eV at half-height. The beam diameter was 0.020 in., and the electric field used to draw out the ions was 1.25 V/cm. The nitrous oxide used was provided by the Matheson Company and had a minimum purity of 98.0%.

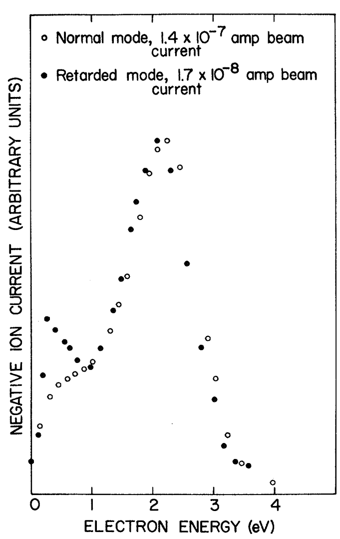

FIG. 1. Negative-ion current as a function of electron energy for "normal" and "retarded" modes of operation. The ordinate at the higher energy peak of the "retarded" curve has been adjusted to match that of the "normal" curve.

The curve taken in the "retarded" mode displays a definite dip between the two peaks, thus revealing structure. Although the electron-energy distribution in each case was about a different centroid, care was taken to calibrate the energy scale for each curve separately and then superimpose the curves so that the energy scales coincided. It is believed that the energy calibration of both curves is now determined in a self-consistent fashion. The threshold for attachment in nitrous oxide appears to be essentially zero. It is to be emphasized that the onset of the negative-ion current in Fig. 1 is not proportional to the cross section since the electron current was not yet "saturated" in this region.

An investigation of the kinetic energy of the ions below 1 eV may be possible by this means upon improvement in signal-to-noise ratio.

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