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THE INTERACTION OF OXYGEN ATOMS WITH SOLID SURFACES AT eV ENERGIES

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This report covers work performed under NASA Grant NGR-47-005-077 during the period 1 June, 1968 to 30 November, 1968.

The entire neutral beam system is now complete and operating. Vacuum tests have been completed and pressures of 1.5×10^{-9} Torr have been achieved in the unbaked target chamber. These pressures are as read by an Ultek nude ionization gauge flange mounted on the chamber.

Before proceeding with recombination measurements it was necessary to determine the cracking patterns of the residual gas analyzer (RGA) for O_2 and other gases that might be used for electron detachment. The cracking patterns were determined by measuring the component mass peak heights as a function of the pressure of the gas being studied, maintaining all RGA parameters constant. The cracking patterns determined in this way are shown in Table I.

TABLE I

CRACKING PATTERNS OF VARIOUS GASES WITH AN ELECTRON ENERGY OF 42 eV

Gas	Atomic Mass	Relative Peak Heights
O_2	32	100
	16	6.47
CO_2	44	100
	28	26.5
	16	9.5
	12	1.73
N_2	28	100
	14	4.1
A_r	40	100
H_2	2	100
	1	1.21

In an attempt to determine the minimum partial pressure we can detect with the RGA we have examined the residual mass peaks at a chamber pressure of about 2.3×10^{-8} Torr. For example, Figure 1 shows the mass range from mass 1 to 57 at this chamber pressure. In Figure 1 one large division represents a current of 3.33×10^{-10}A. Figures 2 and 3 are photographs of a smaller portion of the mass spectrum, specifically from mass 32 to 36, with the sensitivities increased by a factor of 10 and 100 respectively. Thus one large division in Figure 2 represents a current of 3.33×10^{-11}A whereas the same distance in Figure 3 represents a current of 3.33×10^{-12}A. It is seen from Figure 3 that we can easily detect changes in peak heights of about 0.2 of a large division or changes in currents of about 6.67×10^{-13}A. Since the present sensitivity of the RGA is about 1A/Torr, this means we can measure partial pressures of about 6.67×10^{-13} Torr. The partial pressures we expect in the recombination experiments are of the order of 10^{-12} to 10^{-11} Torr, so it is apparent that the RGA has sufficient sensitivity for the proposed measurements.

One unexpected feature of the mass spectrum of the residual target chamber gases is the presence of a relatively large proportion of background signal appearing at mass 16. For example, one can see in Figure 1 that the mass 16 peak is actually larger than mass 18. We are quite certain that this signal is due to methane since it can be shown that contributions to mass 16 from other ambient gases are negligible. Unfortunately, this mass 16 signal is about 100 times larger than the atomic oxygen signal we expect to measure in the recombination experiments. Therefore, we are faced with the task of either reducing the background mass 16 to a level which will permit us to perform the measurements, or to use beam modulation techniques. We are presently constructing an oven to be used for a high temperature bake-out of the target chamber. This should help to reduce both the system pressure and the methane contamination. However, if the bake-out does not substantially reduce the background methane it will indicate that the

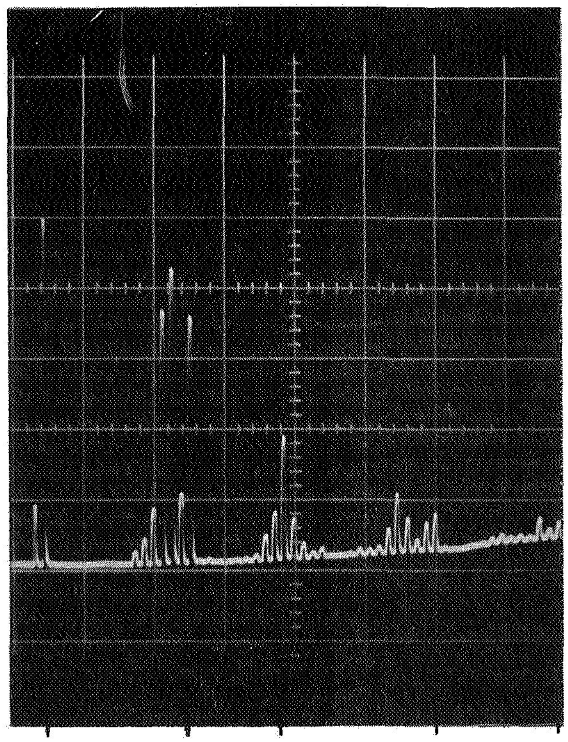

Figure 1

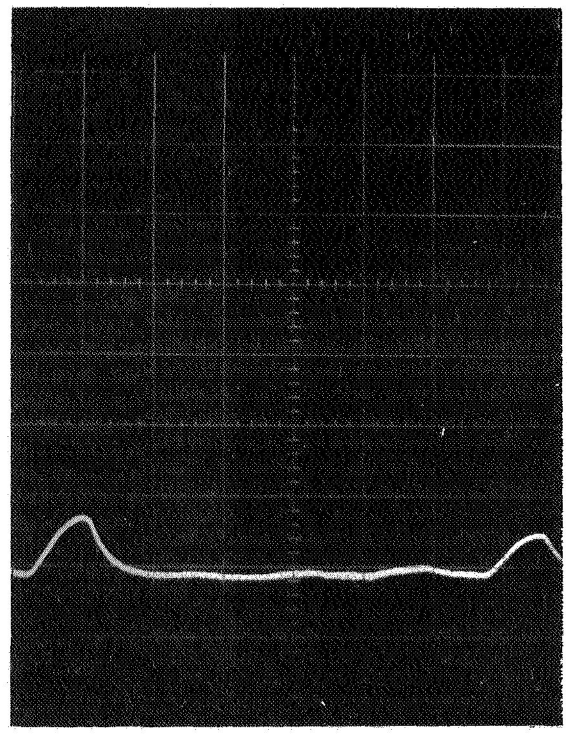

Figure 2

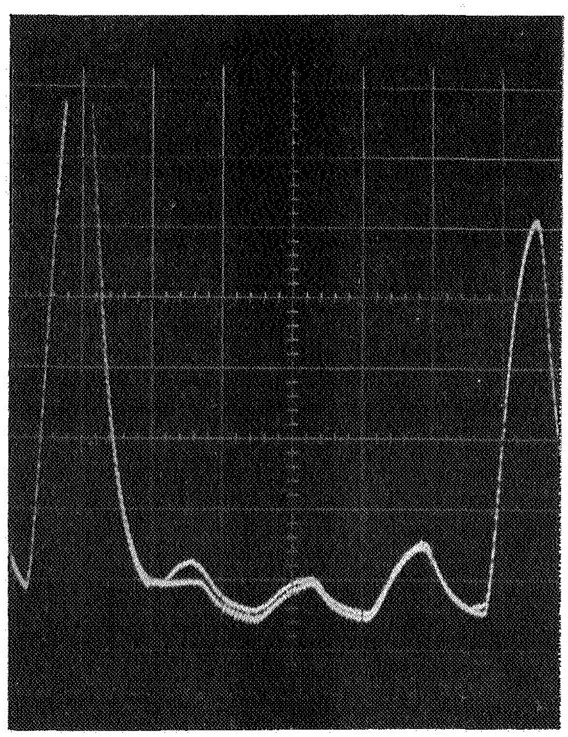

Figure 3

methane is being introduced into the system from the Orb-Ion pump itself. If this turns out to be the case either a new mode of pumping will have to be employed, or beam modulation must be used, or both. This methane contamination problem was completely unexpected, and although serious, we believe that it can be resolved by the procedures mentioned above and the proposed measurements can be performed successfully.

Progress during this period has been hampered due to electronic difficulties in the circuitry of the RGA. Further, it appears as though the electron multiplier has been damaged, most likely due to high voltage arcing. The multiplier damage manifests itself in a high DC level in the multiplier output, forcing us to operate at relatively low electron multiplier voltages and thus at lower sensitivity. These difficulties should soon be resolved and recombination measurements can then proceed.

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