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THE FORMATION OF PROTONS FROM WATER BY ELECTRON IMPACT

H₂O

Livermore, California

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UNIVERSITY OF CALIFORNIA
Lawrence Radiation Laboratory
Livermore, California

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THE FORMATION OF PROTONS FROM WATER BY ELECTRON IMPACT

F. S. Baker

G. O. Brink

July 26, 1962

To be submitted to the Journal of Chemical Physics

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THE FORMATION OF PROTONS FROM WATER BY ELECTRON IMPACT

F. S. Baker and G. O. Brink

Lawrence Radiation Laboratory, University of California

Livermore, California

July 26, 1962

ABSTRACT

The relative cross section for the production of protons from water by electron bombardment has been measured by a modulated crossed beam technique over an energy range from threshold to 500 eV. The appearance potential for protons was measured by comparison with the ionization potential of hydrogen and found to be 19.4 eV. This result is in agreement with earlier results. The overall curve is smooth with the exception of a slight shoulder at about 45 eV. This shoulder may indicate the presence of more than one process for the formation of protons.

THE FORMATION OF PROTONS FROM WATER BY ELECTRON IMPACT*

F. S. Baker and G. O. Brink

Lawrence Radiation Laboratory, University of California

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INTRODUCTION

The formation of protons from water by electron impact has been reported in several earlier papers.^{1,2} The earlier work was, however, concerned only with the region near threshold. In this work the region investigated has been extended to 500 eV.

EXPERIMENTAL METHOD

The relative production cross section was measured by means of a modulated crossed beams technique in which a neutral beam of water molecules was crossed by a dc electron beam. The experimental system has been described elsewhere.^{3,4} The protons formed were extracted at right angles to the two beams by means of a weak electric field and focused into the entrance aperture of a Paul rf mass spectrometer. The ion current at mass 1 was measured by an electron multiplier and phase detector.

Not all of the ions formed were collected by the detection system. Probably some of the protons are formed with sufficient kinetic energy to escape the weak extraction fields used. The transmission efficiency of the detection system was not known. However, a constant fraction of the protons

* Work performed under the auspices of the U. S. Atomic Energy Commission.

formed was extracted and thus a relative production cross section can be determined by the measurement.

It was possible to determine the threshold energy by comparison with a known ionization potential. The ionization potential of hydrogen was used for this purpose and the appearance potentials of the H^+ and H_2^+ ions were measured in order to correct for contact potentials in the electron gun.

RESULTS

Figure 1 shows the positive ion current vs electron energy near threshold. The energy scale has been adjusted so that the threshold energy for the formation of H_2^+ ions occurs at the correct value. This results in a measured value of the threshold energy for H^+ production from H_2O of 19.4 eV. Previous results for this threshold were 18.9 eV by Smyth and Mueller¹ and 19.5 eV by Mann, Hustrulid, and Tate.²

The relative proton production cross section is shown in Fig. 2. The curve is smooth over the entire energy range with the exception of a slight shoulder starting at about 45 eV. The most probable primary process is the reaction

It is possible to write other reactions leading to the formation of protons from water but they all require the breaking of more bonds and hence should not be as probable as the above reaction. It is possible that the shoulder shown by the cross section curve is due to one of these secondary processes.

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Fig. 1. Proton production near threshold.

Fig. 2. Relative proton production cross section.

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