Comparison of the Secondary Electron Emission Due to H_2^+ and D_2^+ Ions

Results of experiments on the secondary electron emission due to bombardment of a hot Ni target by H_2^+ ions have been previously reported.[1] The values obtained ranged from four percent to 22 percent for ions having energies from 300 to 1500 ev.

The same method has now been used to compare the relative emission due to H_2^+ and D_2^+ ions of about the same energy range. The secondary emission, as shown in the accompanying graph, (Fig. 1) is markedly less for D_2^+ than for H_2^+ ions. To obtain these results a Ni target was again used, but after six weeks of continuous heating of the target, when the emission due to H_2^+ had been reduced nearly to the values formerly obtained, the fore pump of the vacuum system suddenly failed to produce the necessary fore vacuum, so that a small amount of air was admitted to the hot target. It was not thereafter possible to reduce the emission to the previous low value. However, reproducible values were obtained and the comparison of the emission due to two ions having so great a relative difference in mass is significant, especially in view of the fact that hydrogen always contaminates a Ni surface and makes impossible the determination of absolute values of emission from a clean Ni surface.

The emission varied approximately linearly from 13.1 percent to 44.7 percent for H_2^+ ions and from 12.2 percent to 35.7 percent for D_2^+ ions over the range of energies used. To be sure that the difference in the effect of the two isotopes was real, the emission for H_2^+ was measured again after the data for D_2^+ were taken and it was found to repeat as closely as before. All points on the curve are averages of a good many values. The deviations in the middle of the curve were not more than two percent. The values at the highest and lowest voltages are the least reliable on account of difficulties in obtaining a large steady positive ion beam at these voltages. The heavier ion is found to produce fewer electrons than the lighter one. This change in emission with mass of the bombarding particle is in the opposite direction to that found by Hill, Buechner, Clark and Fisk[2] for fast ions. The apparent flattening of the D_2^+ curve at higher energies is in agreement with the results of many measurements on secondary emission due to primary electrons. It is also in agreement with the work of Jackson[3] who used alkali ions as bombarding particles. It is not in agreement with any results found by the author for H_2^+ ions. Oliphant[4] found two such changes in slope in the energy range from 80 to 1000 ev for He^+ ions impinging on a Mo target.

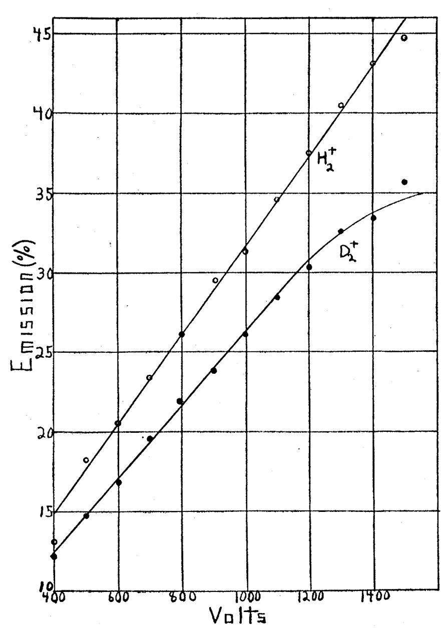

FIG. 1. Relation to energy of secondary electron emission due to H_2^+ and D_2^+ ions.

The increase in the emission over that obtained before, for a Ni surface that is as clean as possible in a hydrogen atmosphere, may be due either to a thin NiO film on the surface or to roughnesses produced by unusual heating of the target in an effort to clean it after its contamination. Güntherschulze and his co-workers[5] report such an increased emission from oxide surfaces over that for pure metals for various metals and gases. Their conclusions were drawn from calorimetric measurements made on the cathode of an anomalous glow discharge.

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Interaction of Fast Neutrons with Protons

The interaction of neutrons with protons, as shown by the scattering by protons of neutrons of not too inhomogeneous velocities, has been confined hitherto to neutrons of three Mev or less. We have measured the neutron-carbon and neutron-proton cross sections for higher energies and present here the results of measurements with neutrons of about 15 Mev.

The neutrons from a lithium target bombarded by 0.9-Mev deuterons were all of energies less than 16 Mev (calculated from the mass data of Allison[1]); the threshold of copper, the detector used, is, according to Sagane,[2] between 12 and 13 Mev. Experiments on the angular distribution of the neutrons from the target lead us to believe that the activity of the copper (10.3-minute period) was due predominantly to the neutrons in the higher portions of the 12–16-Mev range.

The scattering was measured by the reduction in intensity of the neutron beam when it traversed paraffin and graphite, cut into truncated cones just large enough to intercept all the neutrons traveling from target to detector. The observed transmissions ranged from 40 to 80 percent, with paraffin 0.54 and 0.84 g/cm² and graphite 0.49 and