"Beam cleaning" with Argon ions and hot vacuum chamber

Run 246 - 31st October 1972, Ring 1, 2C22

Purpose: to find out whether the desorption coefficient $\eta$ can be reduced by bombardment with beam produced ions.

Result: negative. After the experiment $\eta$ was considerably higher than before. The previously negative $\eta$ has increased and even become positive for ion energies above 1000 volts.

Introduction:

The aim of the experiment was to produce the highest possible ion bombardment per square centimetre by working at the highest stable beam current and pressure and to observe the effect on $\eta$. The primary ions should be of a species which does not adsorb on the surface. For this reason and because of the high molecular weight Argon has been selected. To reduce the readsorption of molecules the treatment was done with the chamber at 200°C.

Preparation of the experiment:

During run 245 $\eta$ as function of ion energy has been determined in section 333, see curve 1 in the attached figure. Since the section had already a rather low $\eta$ it was decided to contaminate the test sections in order to get initially a higher $\eta$ with the hope of improving it by the beam cleaning. The contamination was done by creating an air leak at point 333.5 and raising the pressure to about $5 \times 10^{-8}$ torr for 4 hours. Following this treatment the section was baked at 130°C and at 190°C for 2 hours each. The reason for this bake was to remove all those weakly adsorbed molecules which otherwise would desorb by the temperature increase of the main experiment.
Experiment:

The $\eta$ as found before the ion bombardment is shown by curve 2 in the figure. Over the full range measured $\eta$ remained always negative. This is quite interesting if one considers the rather harsh treatment this section had undergone. The existing 8 A stack was kept circulating while the heating tapes in straight section 333 were turned on. As soon as the chamber temperature had reached $185^\circ$C the preadjusted leak was opened which resulted in a pressure increase from $2 \times 10^{-10}$ torr to about $6 \times 10^{-9}$ torr. The beam current was topped up to 9 A, the maximum which Ring 1 tolerated and was maintained at this level by adding a few pulses from time to time. The pressure kept increasing and reached $8 \times 10^{-8}$ torr towards the end of the experiment. The total ion bombardment in 3 hours was about $2 \times 10^{13}$ ions/cm$^2$. In order to obtain a uniform distribution of the ions around the circumference, the top electrode was put to ground potential. The ion energy of about 900 volts was considered as sufficient since in a normal Argon discharge it is only of the order of 200 volts. After three hours the heating was turned off and the leak closed. Unfortunately the cooling down took more than 1½ hours and in addition the pressure did not recover quickly and had not reached equilibrium by the end of the experiment. It was therefore not possible to compare the $\eta$ before and immediately after the experiment. It took in fact more than 48 hours for the pressure to settle down at an equilibrium. The comparative measurement of $\eta$ was therefore done in run 250 and the disappointing result is shown as curve 3. The $\eta$ of section 333 had even further increased and was now even positive for ion energies above 1000 volts.

Conclusions:

With $2 \times 10^{13}$ ions/cm$^2$ it was possible to bombard between 2 and 5% of a monolayer surface. In a "normal" discharge cleaning one aims at $10^{18}$ ions/cm$^2$. As should be the case, the Argon ions were indeed very strongly desorbing and the $\eta$ obtained by E. Fischer's method was of the order of 0.9. Nevertheless the overall result is negative which suggests that the gas molecules desorbed from the wall had time enough to readsort before they were taken out by the pumps.

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\[ \frac{p}{S \alpha} \frac{1}{1 - \frac{P_o}{P}} \]

Graph:
1. Before contamination, in air at 245 mm.
2. Before ion bombardment, following 4th contamination at 6 x 10^-2 Torr of air at 130°C and 180°C.
3. After ion bombardment.

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