# SURFACE PRETREATMENT TEST ON TMR ALUMINUM CHAMBERS BY ELECTRON BOMBARDMENT

K. Narushima, K. Kanazawa, H. Mizuno, T. Momose, and H. Ishimaru.
National Laboratory for High Energy Physics
Oho-machi, Tsukuba-gun, Ibaragi-ken, 305, Japan

## ABSTRACT

To decrease the gas desorption due to synchrotron light, the effect of electron bombardment on chambers was investigated. The effect of factor 3 was observed between the chambers with and without bombardment. The factor was preserved even if the chamber was exposed to an atmosphere.

## INTRODUCTION

In the TRISTAN Main Ring (MR), synchrotron light of 2.6 KW/m (30 GeV, 7 mA; $e^+$, $e^-$) is radiated on the aluminum alloy vacuum chambers. The radiation induces photo-electron desorption. The electron desorption rate could be $10^{14}$ molecules/cm$^2$.sec under high surface coverage conditions[1]. The pressure rise due to the desorption decreases as beam current time integral increases. It is estimated, however, that the required pressure with beam of the AR could be reached after $10^4$ mA.h (1 year) operation[2]. In developing the method for reducing the operation time of the MR to get the required pressure, it is interesting to know if the pressure rise could be reduced by applying pretreatment on vacuum chambers. Electron bombardment was applied on chambers of the MR and the bombarded chambers were exposed to the synchrotron light of the AR.

## EXPERIMENT

Electron induced desorption measurements were made with a diode system as shown in Fig.1. A filament was a 30 cm long tungsten ribbon (0.0254 mm x 0.762 mm). Current of the filament was regulated by a power supply (0-50 V). Negative potential of the filament was variable from 0 to -10 KV.

The sample chambers were 30 cm long quadrupole chambers for the MR. They are specially extruded aluminum alloy chambers[3] and were degreased in toluene. The system was evacuated by a 200 l/s turbomolecular pump. After baking, total pressures less than 1 x $10^{-9}$ Torr were routinely attained. Total pressure was measured with a B-A gauge. Partial pressures were measured with a quadrupole mass filter (QMF). During measurement, the electron current and the total pressure rise were monitored and the gas species were also analyzed by the QMF.

As shown in Eq.(1), the molecular desorption yield $\eta$ (molecules/electron) was obtained from the pressure rise, $\Delta P_{tot.}$ (Torr), the electron current, $I_e$ (A), and the pump speed, S (l/s),

$$\eta = 5.1 \times S \times \Delta P_{tot.}/I_e. \qquad (1)$$

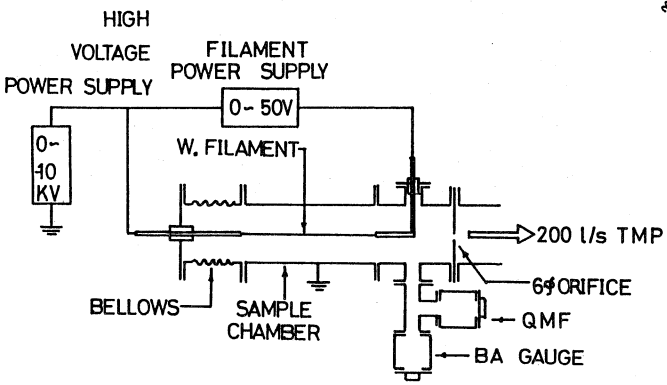


Fig.1 Diode system for electron induced desorption measurements.

After the electron bombardment test, the sample chambers were exposed to the synchrotron light of the AR (2.55 GeV).

## RESULTS AND DISCUSSIONS

### Electron bombardment

Fig.2 shows the results of 3 types of electron bombardment test at 5 KV.

### Electron bombardment without baking

During the bombardment, the temperature of the chamber increased to 130°C because of heating by the filament. Therefore the chamber was cooled down to 40°C for the first bombardment. The result is shown in Fig.2 with white circles. At the total dose of 500 mA.h (1.3 x $10^{19}$ electrons/cm$^2$), $\eta$ was about $10^{-3}$.

### Exposure to an atmosphere for 18 hours

The chamber was vented to dry $N_2$ gas. After the chamber was kept to an atmospheric pressure for 18 hours, the second bombardment was applied to the chamber. While the total dose was less than 20 mA.h, desorbed gas was one third of the outgas in the first bombardment. On the contrary, $\eta$ was 2 x $10^{-3}$ at the total dose of 20 mA.h or more and approached to the curve of the first bombardment. It is concluded that the bombarded chamber shows lower $\eta$ even if the chamber was exposed to an atmosphere.

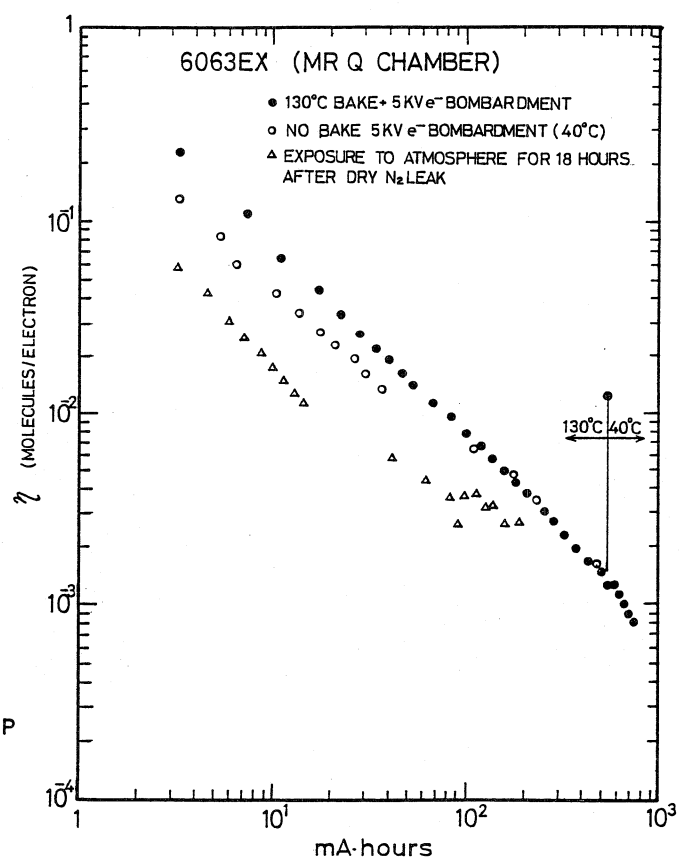


Fig.2 Molecular desorption yield by electron bombardment.

Electron bombardment with baking at 130°C

To make the treatment efficiently, the bombardment at 130 °C (without cooling) was tried. At the total dose of 500 mA.h, the quantity of desorbed molecules was 1.2 x $10^{17}$ molecules/$cm^2$. This value suggests that adsorbed gases on the surface were completely desorbed. Therefore $\eta$ decreased rapidly on the order of $10^{-4}$ after the chamber was cooled from 130°C to 40°C. This result shows that electron bombardment at high temperature (130-150°C) is efficient as for the pretreatment.

Synchrotron radiation test on the electron bombarded chambers

To evaluate the effect of the pretreatment, the sample chambers were exposed to the synchrotron light of the AR (2.55 GeV).

For comparison, a chamber with no bombardment was also irradiated by the synchrotron light. The result is shown in Fig.3. Peak height of $H_2O$ and $CO_2$ is larger than that of $H_2$ and CO. The result shows that adsorbed gases on the surface are dominant and that the gas desorption from inside surface is small.

The result of the radiation test on the electron bombarded chamber (500 mA.h) is shown in Fig.4. Because of the exposure to an atmosphere after the bombardment, $H_2O$ was observed during earlier radiation. At the dose of 20 mA.h or more, $H_2O$ decreased and $H_2$, CO, and $CO_2$ are dominant. This fact suggests the desorption from the inside , but larger peak of CO shows that the desorption from the surface is more dominant. $\Delta P_{tot.}$ is low about factor of 3 than that of the chamber with no bombardment. This is the effect of the pretreatment, which is not so large as we expected from the electron bombardment test.

The radiated chamber was exposed to an atmosphere for 30 hours, and then radiated again. The result is shown in Fig.5. $\Delta P_{tot.}$ is nearly the same in both cases (Fig.4 and Fig.5). From this fact it can be concluded that the chambers memorized the radiated and/or electron bombarded effects. The data of partial and total pressures began to decrease at $10^2$ mA.h as shown in these figures. Further experiment with much higher dose is necessary to confirm if the tendency is the similar effect shown by other experiment[4].

In these three results, peak height of $CO_2$ is relatively high. It is not clear whether $CO_2$ came from the tungsten filament or not. It must be paid attention that the chambers should not be contaminated by the element.

CONCLUSIONS

Surface pretreatment by electron bombardment was tried on the TMR Al chambers to reduce the photo-induced desorption. Bombardment effect was memorized after exposed to an atmosphere. The difference in $\eta$ is factor of 4. Radiated and/or electron bombarded effect was also memorized after the exposure. The difference in $\Delta P_{tot.}$ is factor of 3. Although further experiment is needed, the electron bombardment is promising as for the pretreatment of the TMR vacuum chmbers.

REFERNCES


1. E. L. Garwin, et al., Proc. of the 4th International Vacuum Congress, 1968.
2. T. Momose, et al., "Operation of the TRISTAN Vacuum System, Injection Line and Accumulation Ring", this proceedings.
3. K. Narushima, et al., Journal of the Vacuum Society of Japan, No.5, 25, 1982, 172.
4. O. Groebner, et al.,Vacuum, No.7, 33, 1983,397.


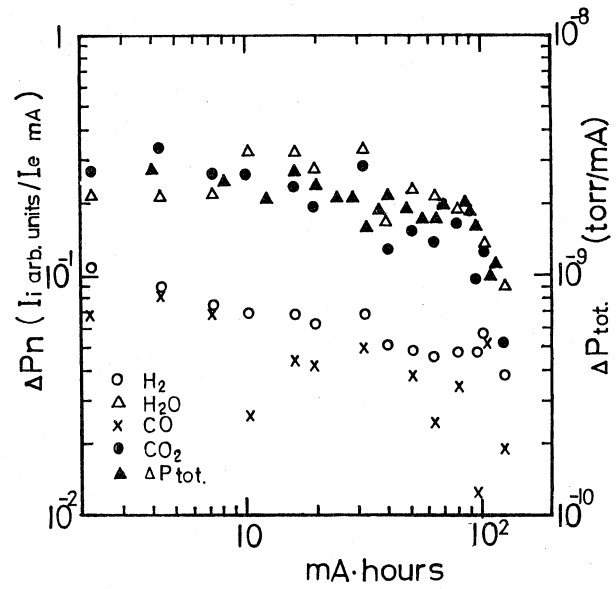


Fig.3 Partial and total pressures of the no bombarded.

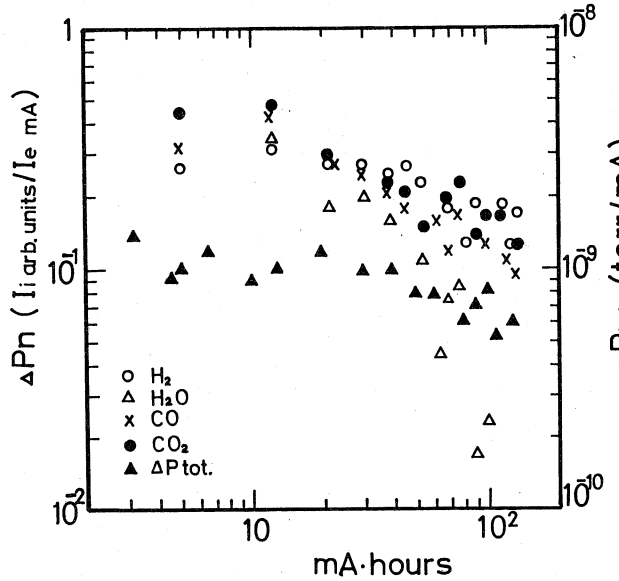


Fig.4 Partial and total pressures of the bombarded.

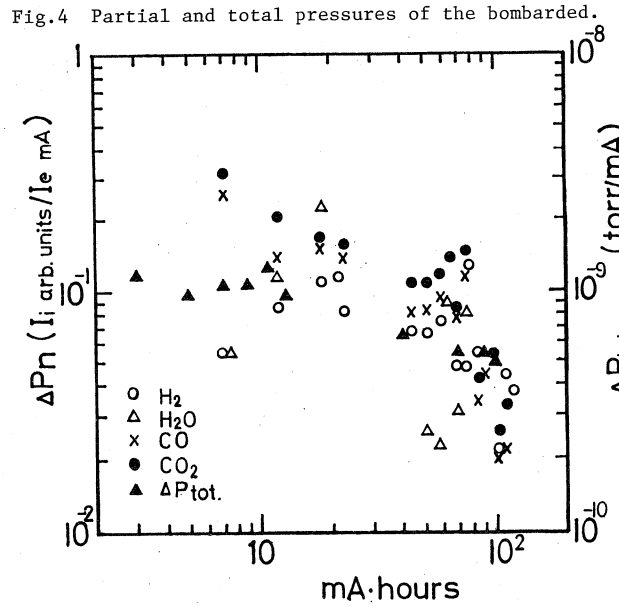


Fig.5 Partial and total pressures of the exposed for 30 hours after bombarded 500 mA.h.