A.5.4. Damage and Curing of a Multi-channel Plate (MCP) Detector under Heavy Ion Bombardment—*Hiro Tawara, D. Fry, and Martin Stöckli*

The KSU EBIS is a unique facility which can provide various ions (mass = 1 - 238) with different charge states (q=1 - ~ 70) over a very wide range of the bombarding energy (0.1 keV – 10 MeV). In the present work, we have tried to investigate and understand the responses of a multi-channel plate (MCP) particle detector to such various ions, which are most commonly used in atomic physics experiments.

So far, most of our common knowledge tells us that during long periods of the ion bombarding time, the gain of the multi-channel plate detector deteriorates, in particular for heavy ion bombardment.

In the present experiment, we have observed how the pulse heights and their distributions (PHD) from the MCP change during ion bombardment under a vacuum in the 10^{-9} Torr region. Some general observations are as follows: The peak (most likely) positions and high energy tail ends of the PHD move toward the higher side as the projectile ion charge and also its bombarding energy increase, thus it becomes easier to discriminate against background noises. These have quite ubiquitously been observed so far.

We have carefully looked at MCPs under Si ion bombardment. Figure 1 shows a typical dependence of the peak positions (maximum intensities) of the PHD on the ion fluence under 65 keV/amu Si^{12+} ion bombardment. (The count rates of the incident ions are kept below a few thousand counts per second to avoid the distortion of the PHD). We estimated from the known bombarded area of the present MCP that at the maximum fluence one of the multi-channel capillaries in the MCP was hit at least once by the incident ions.

Though the detailed behavior has been found to depend upon the bombarding history and other factors such as the storage conditions, the common features observed are as follows: At the beginning of the ion bombardment, the position of the peak intensity in the PHD moves quickly to the lower side (indicating the loss of the gain). This phenomenon, often called the initial gain loss, is easily understood to be due to the cleaning up of the surfaces through removal of contaminants under ion bombardment (most likely hydro-carbon molecules which are known to significantly increase the secondary electron emission rate from solid surfaces if they are adsorbed). Then, after passing a minimum (gain) position, the peak positions start to increase toward higher channels, indicating some recovery effect due to the ion bombardment and finally becomes constant and are well stabilized. If the ion bombarding conditions do not change, this position is kept for quite a long time. But once the ion bombardment has stopped, for example overnight, then, similar behavior is again observed; but the gains quickly recover and the peak positions become stabilized at the same position as before.

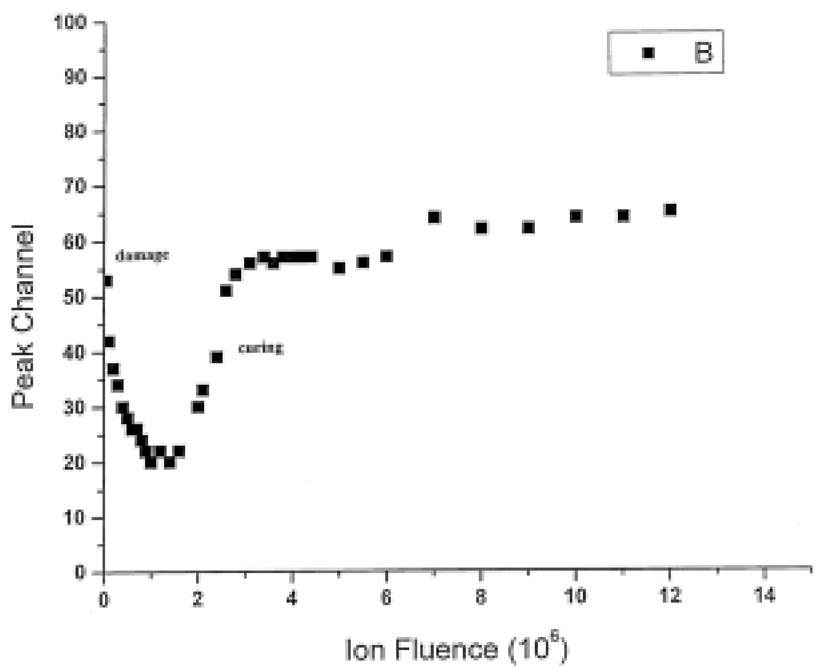

Figure 1. Peak positions in pulse height distributions from MCP under 1.83 MeV Si^{12+} ion bombardment.

This observed recovery is unexpected but can be understood to be due to the surface irradiation effect by heavy ions where not only surface cleaning but also some extracting effects of some sintered materials in the MCP may play a role. We have also tried to use other heavier ions such Ta ions. The results are nearly the same as described above.

It has also been found that keeping high voltage applied on the MCP does not help keep the surface clean and also, without high voltage applied to the MCP, the surfaces of the MCP get contaminated soon, resulting in the initial gain loss.