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# Measurement of ion-induced secondary electron emission coefficient for MgO thin film with $O_2$ plasma treatment

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## ABSTRACT

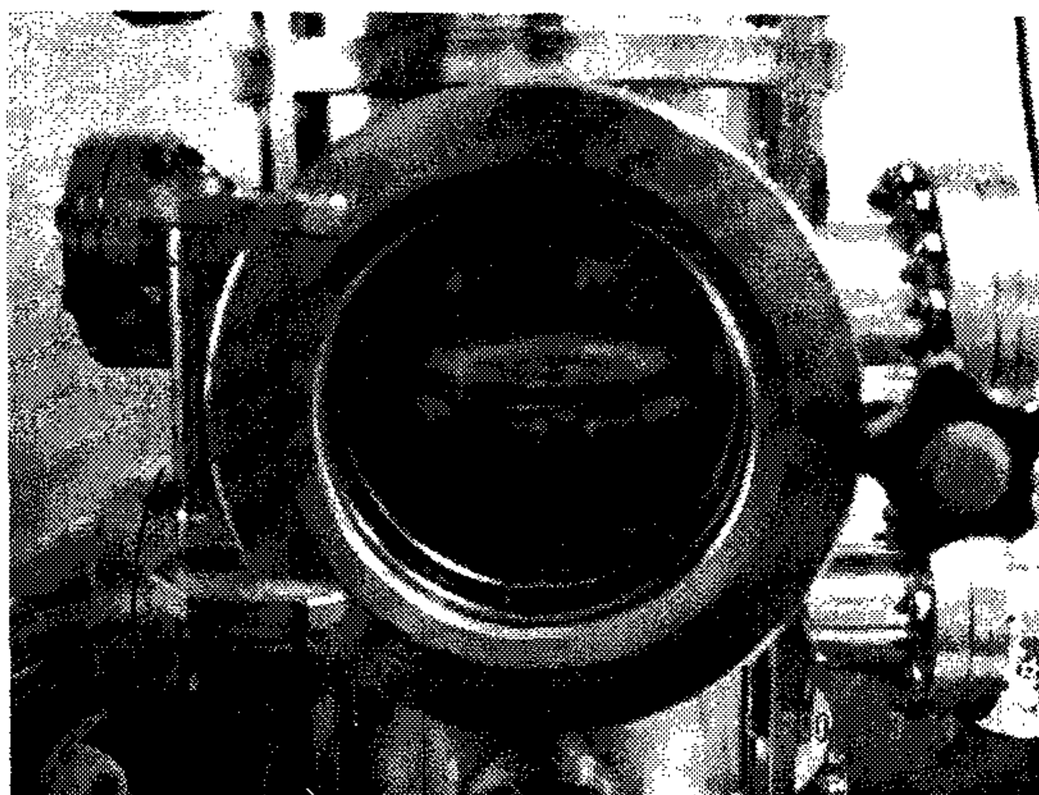
The ion-induced secondary electron emission coefficient $\gamma$ for MgO thin film with $O_2$ plasma treatment has been investigated by $\gamma$ -FIB (focused ion beam) system. The MgO thin film deposited from sintered material with $O_2$ plasma treatment is found to have higher $\gamma$ than that without $O_2$ plasma treatment. The energy of $Ne^+$ ions used has been ranged from 100eV to 200eV throughout this experiment. It is found that the highest secondary electron emission coefficient $\gamma$ has been achieved for 10 minutes of $O_2$ plasma treatment.

## INTRODUCTION

The characteristics of MgO protective layers are very important for the development of recent AC-type plasma display panel (AC-PDP) [1,2]. The ion-induced secondary electron emission coefficient $\gamma$ is one of the characteristics of the MgO protective layer which correlates to the ignition voltage of AC-PDPs[3]. Recently many researchers have been studying to get the highest $\gamma$. Therefore we selected the method of oxygen ($O_2$) plasma treatment and used other gases for MgO protective layer. In this research, We used two steps of MgO protected layer growing method to get higher quality of it. First MgO thin films were prepared by using electron beam evaporation method from sintered materials. And then they were treated by oxygen plasma by using RF-plasma generation system. The ion-induced secondary electron emission coefficient $\gamma$ of MgO protective layer was measured by $\gamma$ -FIB (Focused Ion Beam) system throughout this experiment [4] to investigate the influence of these plasma treatments on it.

## Experimental Configuration

The MgO protective layers are deposited on the glass by electron beam evaporation method and vacuum annealed under 200℃ about 20 minutes after the deposition. The thickness of MgO thin film is 5000Å. The deposition rate is 5Å/s. In this experiment, $Ne^+$ ions are used for the measurement of $\gamma$ by varying its energy from 100eV to 200eV. The MgO thin films deposited from sintered material are treated by the $O_2$ plasma. The $O_2$ plasma treatment durations of the MgO thin films are adjusted by 5 and 10 minutes, respectively. The two MgO thin films are treated by $O_2$ plasma, while the other MgO thin film has not been treated by the $O_2$ plasma in this experiment.



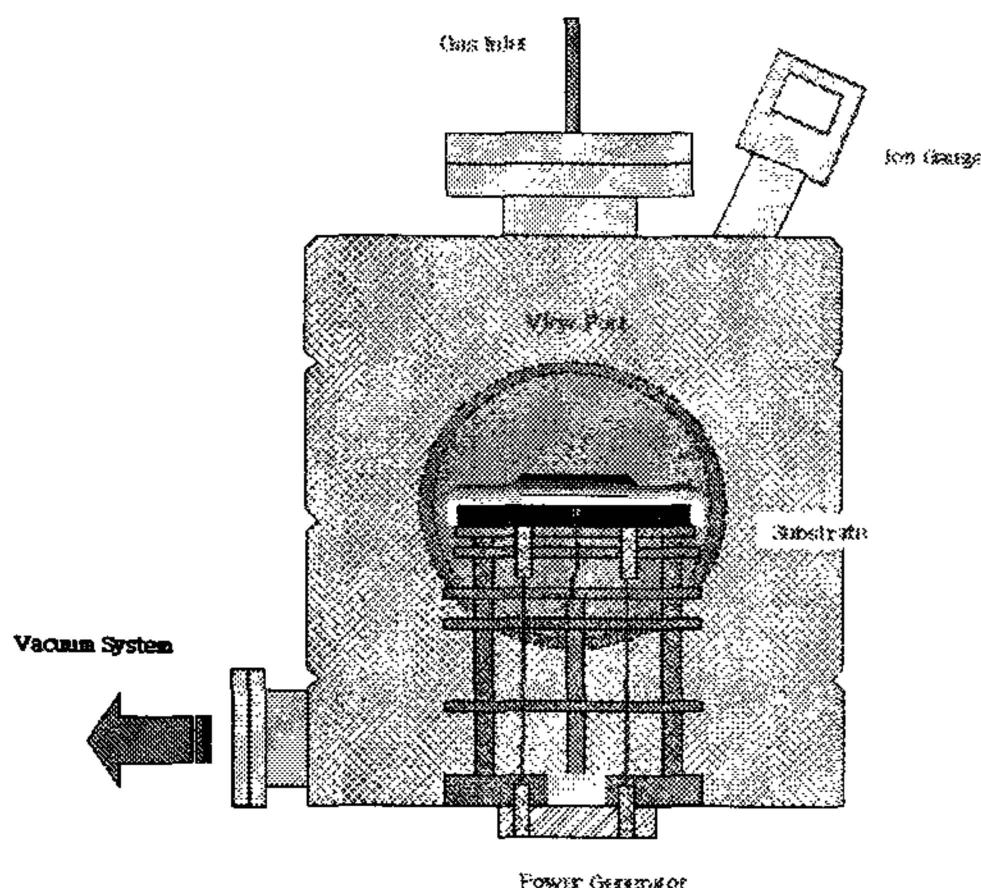


**Figure 1.** The RF-Plasma Generator

Figure 1 shows the RF-plasma generator for the $O_2$ plasma treatment. The RF-plasma treatment conditions are summarized in table 1.

| Experimental Variable | Value |
|---|---|
| % of $O_2$ in $O_2$ + Ar mixture | 50 |
| Substrate temperature (℃) | R. T. 300 |
| Treatment pressure (mTorr) | 105~200 |
| Treatment time (min) | 5.10 |
| RF power at treatment (Watt) | 15 |

**Table 1.** Plasma treatment conditions

Figure 2 shows the schematic γ-FIB system for measurement of secondary electron emission characteristics from MgO thin film. The γ -FIB system is broken down into five basic components: the diode consisting of thermionic electron source and anode, electron-impact ion formation and its acceleration region, electrostatic single Einzel lens for ion beam focusing, quadrupole deflector, and substrate for γ measurement of MgO thin film, respectively. The background vacuum pressure of γ -FIB is maintained at $1.6\times10^{-5}$ Torr, whereas it is kept by up $7\times10^{-5}$ Torr during ion beam formation mainly at the nearby region of 2mm-diam. anode hole by gas feeding. The ions are produced by impact collisions of thermal electrons emitted from filament to the He, Ne, Ar, $N_2$, and Xe atoms. The kinetic energy of ions is depended on the ion accelerating voltage applied to the anode. The anode positive biased and can be +50 up to +500V for the ion acceleration, and these ions are passed through the 0.5mm-diam. beam defining aperture along downstream of the system. The ion beam is the focused by single electrostatic Einzel lens and scanned by the quadrupole deflector onto the MgO surface with fixed beam diameter of 80 um throughout this experiment, which can be achieved by adjusting the filament heating current under the given ion acceleration energy.

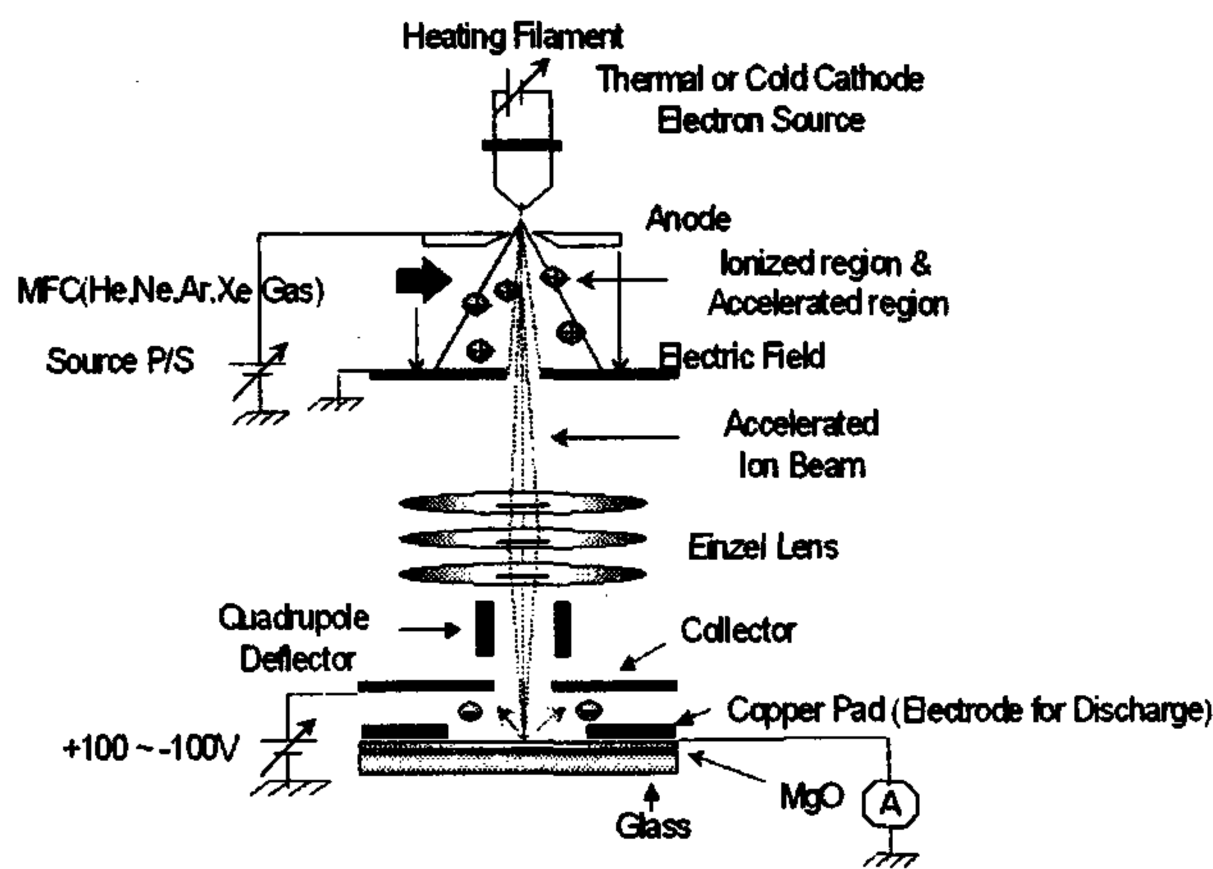



Figure 2. The schematic of **γ-FIB system**

## Experimental Results and Discussions

Figure 3 shows the secondary electron emission coefficient obtained for MgO protective layers deposited from sintered material with $O_2$ plasma treatment by 5, 10 minutes and without plasma treatment, which are characterized by solid squares, solid triangles and solid circles, respectively, versus $Ne^+$ ion accelerating voltage from 100 eV up to 200 eV. The MgO thin film with $O_2$ plasma treatment by 10 minutes has been found to have higher γ values than those for other MgO films for above $Ne^+$ ion energy ranges. It is noted that the γ of MgO films with $O_2$ plasma treatments by 10 minutes is shown to be from 0.13 up to 0.28, which is 3 times of those with 5 minutes and without plasma treatment, versus Ne+ ion ranged from 100 eV to 200 eV.

## Conclusion

It is found that secondary electron emission coefficient γ of MgO thin film with $O_2$ plasma treatments by 10 minutes has been remarkably increased from 0.13 up to 0.28, which is 3 times of those with 5mintues and without plasma treatment versus $Ne^+$ ion ranged from 100 eV to 200 eV in this experiment.

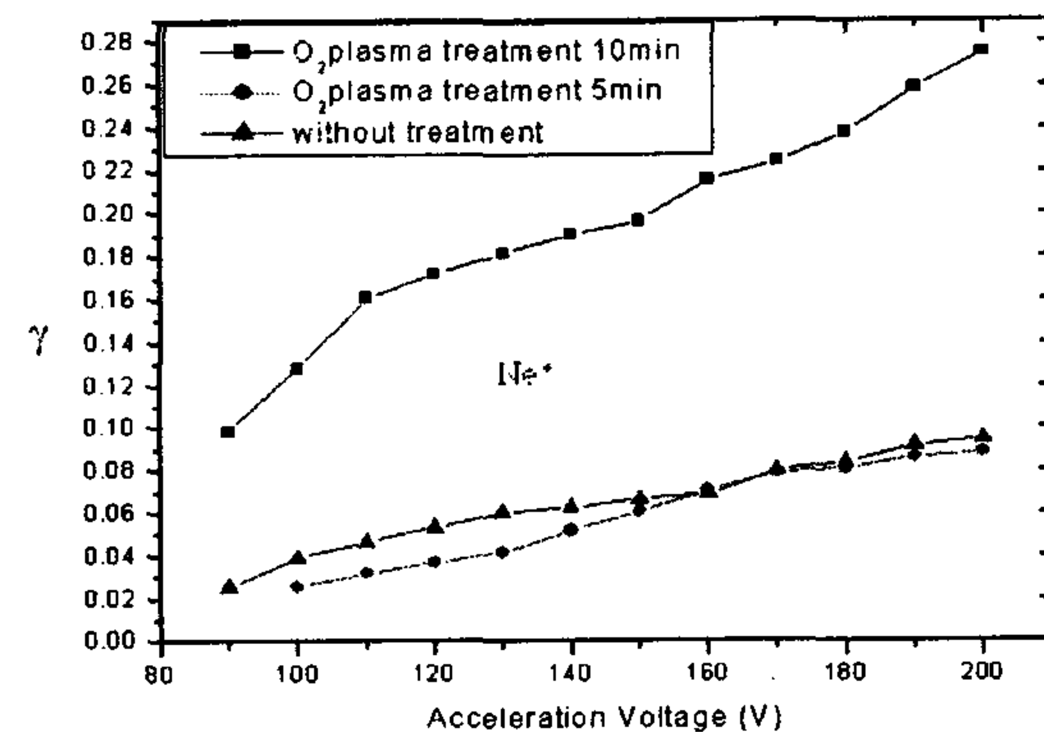



Figure 3. **γ from the MgO thin film with plasma treatment with different treatment time**

## Acknowledgements

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