# Influence of vacuum annealing on the secondary electron emission coefficient (γ) from a MgO protective layer

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## Abstract

The secondary electron emission coefficient(γ) of vacuum annealed MgO films has been investigated by γ-focused ion beam(γ-FIB) system. The vacuum annealed MgO films have been found to have higher γ values from 0.053 up to 0.121 than those for as-deposited MgO films from 0.026 up to 0.062 for $Ne^+$ ion energies ranged from 50eV to 200eV. Also it is found that γ for air hold of vacuum annealed MgO layers for 24-hours is similar to that for vacuum annealed MgO films without any air-hold.

## Introduction

MgO films is widely used for protective layer of AC plasma display panels(AC-PDPs) because of their high durability with good protection ability from ion bombardment and high secondary electron emission coefficient(γ). The endurance of the protective layer against sputtering is one of the decisive factors for the life span of the PDP. And high secondary electron emission coefficient have important roles in lowing the firing voltage.[1,2]

MgO films as the protective layer in AC-PDPs is generally annealed under vacuum environment in order to eliminate absorbed materials on the MgO layer. Vacuum annealing is one of the most important processes for forming long-lived panel.[3] It is of great importance to investigate the influence of vacuum annealing on γ from a MgO protective layer. In this research, γ of the vacuum annealed MgO films has been investigated by γ-focused ion beam(γ-FIB) system[4]. Also, the characteristics of γ for as-deposited and vacuum annealed MgO films have been investigated and compared with each other throughout this research.

## Experimental Configurations

Figure 1 shows the schematic diagrams of γ-FIB system for measurement of secondary electron emission characteristics from MgO films. The MgO protective layer is deposited on the dielectric layer by electron beam evaporation at deposition rates of approximately 5~10Å/sec in a vacuum of about 1.1×$10^{-6}$ Torr. The thickness of MgO layer is about 5000Å. The deposited MgO films have been vacuum annealed at 300℃ for 15 minutes. Also some of the as-deposited MgO films has been air-hold by 24-hours in this experiment. The secondary electron emission coefficient characteristics for these two MgO films have been measured by γ-FIB system and compared with each other throughout the experiment.

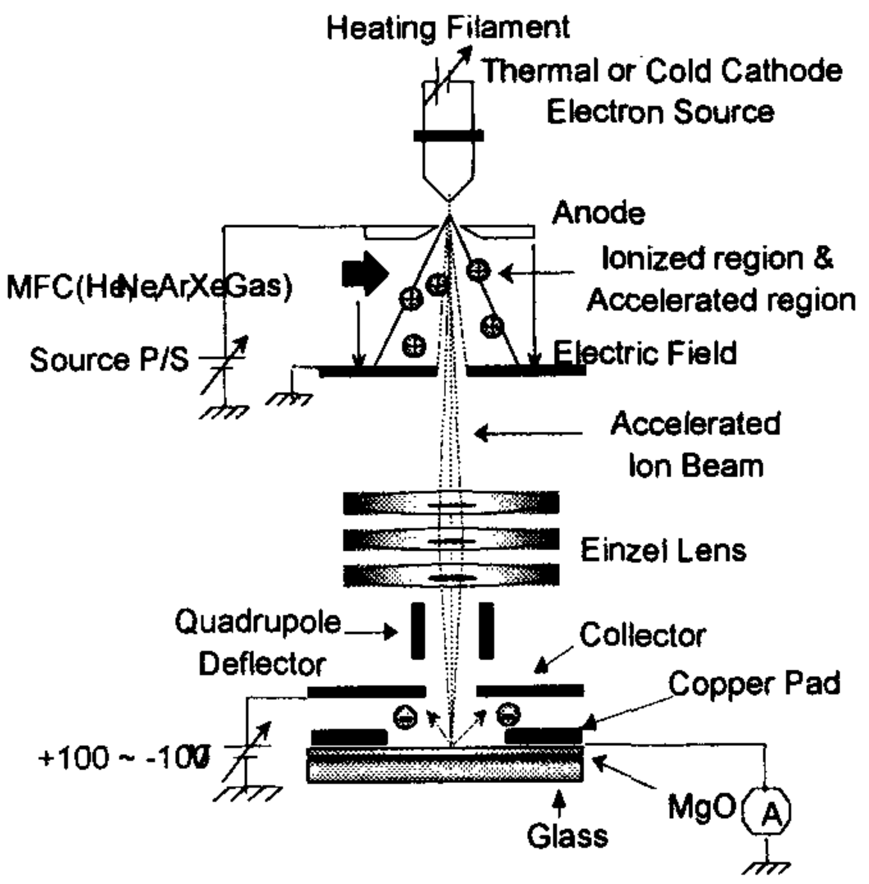

Fig.1 . Schematic diagrams of γ-FIB system for measurement of secondary electron emission coefficient from MgO protective layer.

## Experimental Results & Discussions

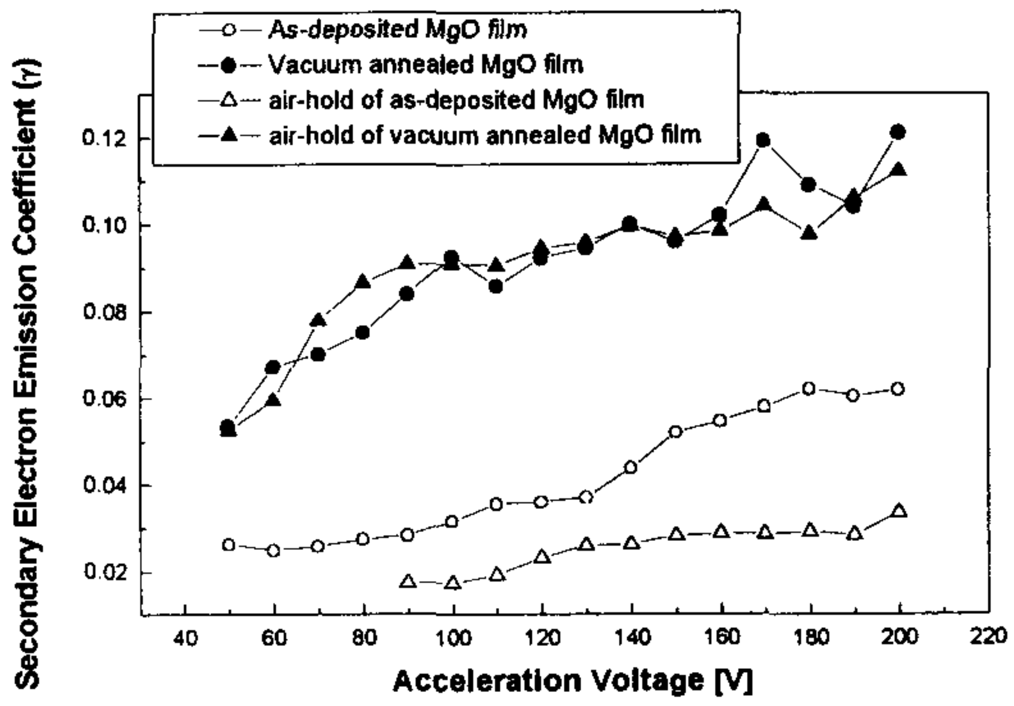

Fig. 2. γ for various kinds of MgO films versus $Ne^+$ ion acceleration voltages.

Figure 2 shows $\gamma$ of MgO films for as-deposited, vacuum annealed , air-hold of as-deposited, and air-hold of vacuum annealed one, which are characterized by open circles, solid circles, open triangles, and solid triangles, respectively, versus $Ne^+$ ion acceleration voltages 50V up to 200V. The vacuum annealed MgO films have been found to have the highest $\gamma$ from 0.053 up to 0.121, while to have the lowest $\gamma$ from 0.018 to 0.03 for the air-hold of as-deposited MgO films by 24-hours for operating $Ne^+$ ions ranging from 50eV to 200eV throughout this experiment. It is noted that the $\gamma$ for air-hold of vacuum annealed MgO films by 24-hours is similar to that for vacuum annealed MgO films. It is also found that the $\gamma$ for as-deposited MgO films has been worse if it is exposed to atmospheric air environment.

These facts are attributed to the surface conditions, morphology, impurities, and contaminations of MgO films. Generally as-deposited MgO films contain significant amounts of OH groups. The vacuum annealed MgO films at 300℃ significantly could remove the amount of surface OH groups. The OH groups are dehydrated by annealing result in decrement of work function, therefore the secondary electron emission coefficient of the vacuum annealed MgO films shows the highest value.

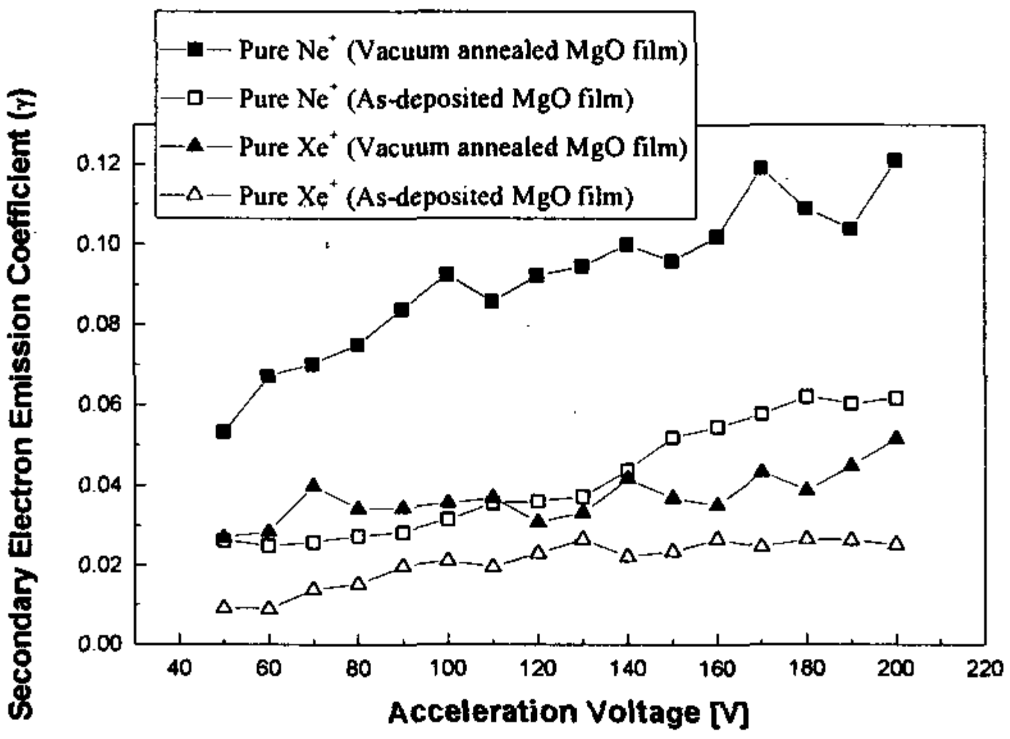

Fig. 3. $\gamma$ of as-deposited and vacuum annealed MgO films for pure $Ne^+$ and $Xe^+$ ions versus ion acceleration voltages.

Figure 3 shows $\gamma$ for as-deposited and vacuum annealed MgO films for $Ne^+$ and $Xe^+$ ions, respectively, versus ion accelerating voltages 50V up to 200V. The vacuum annealed MgO films have been found to have the highest $\gamma$ from 0.053 up to 0.121 for operating $Ne^+$, while from 0.03 up to 0.05 for $Xe^+$ ions, respectively, ranging from 50eV to 200eV throughout this experiment. It is noted that the ions with larger ionization energy have the higher secondary electron emission coefficient by Auger neutralization theory [5].

Figure 4 shows $\gamma$ for air-hold by 24-hours of as-deposited and vacuum annealed MgO films according to pure $Ne^+$ and $Xe^+$ ions, respectively, versus ion accelerating voltages 50V up to 200V. It is noted that the $\gamma$'s for air-hold of vacuum annealed MgO films are similar to those in Fig.3 for vacuum annealed MgO films without any air-hold. It is also noted that the $\gamma$'s for air-hold of as-deposited MgO films are lower than those in Fig.3 for as-deposited one.

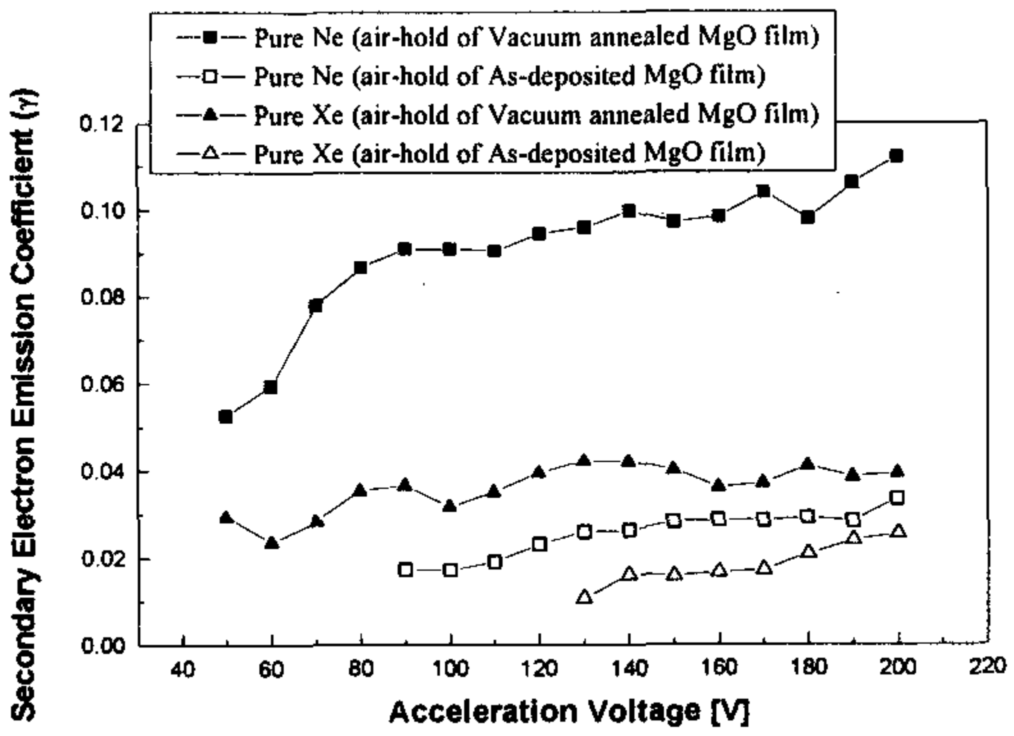

Fig. 4. $\gamma$ for air-hold of as-deposited MgO films by 24-hours and vacuum annealed one for $Ne^+$ and $Xe^+$ ions, respectively, versus ion acceleration energy.

## Conclusion

$\gamma$ of vacuum annealed MgO films has been investigated by $\gamma$-FIB system. The annealed MgO films have been found to have higher $\gamma$ values from 0.053 to 0.12 than those from 0.026 to 0.062 for as-deposited MgO films for operating $Ne^+$ ion energies ranged from 50eV to 200eV. The vacuum annealed MgO films or air-hold of it have been found to have the highest $\gamma$ while to have the lowest one for the air-hold of as-deposited MgO films. Based on these facts, it can be concluded that vacuum annealed MgO protective layer plays an important role in lowering the firing voltage in AC-PDP compared with the as-deposited or air-hold of as-deposited MgO protective layer.

## References

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