Measurement of secondary electron emission coefficient(γ) with oblique low energy ion and work function ϕ_ω of the MgO thin film in AC-PDPs

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ABSTRACT

Oblique ion-induced secondary electron emission coefficient(γ) with low energy and work function ϕ_ω($\theta = 0$ and $\theta = 20$) of the MgO thin film in AC-PDPs has been measured by γ-FIB system. The MgO thin film has been deposited from sintered material under electron beam evaporation method. The energy of He^+ ions used has been ranged from 50eV to 150eV. Oblique ion beam has been chosen to be 10 degree, 20 degree and 30 degree. It is found that the higher secondary electron emission coefficient(γ) has been achieved by the higher oblique ion beam up to inclination angle of 30 degree than the perpendicular incident ion beam.

INTRODUCTION

The characteristics of MgO thin film are very important for the development of AC-PDP[1],[2-3]. Ion – induced secondary electron emission coefficient(γ) is one of characteristics of MgO thin film, which correlates to the ignition voltage of PDPs. Previous study[4] indicates that the breakdown voltage in PDP cells decreases significantly with increasing the ion-induced secondary electron emission coefficient from the MgO protective layer. The electric field has been formed along the various discharge paths on the panel space in coplanar AC-type plasma display panel because two horizontal sets of parallel electrodes are deposited on glass substrates and discharge occurs between two electrodes on the same plate[5]. Therefore, The electric field is forming the arch line between the sustaining electrodes during discharge in coplanar AC-type plasma display panel, as shown in Fig1. [5]. The ion, which has been accelerated by the electric field, is approaching to the MgO protective layer. The accelerated ion is obliquely approaching with an angle to the MgO surface. In this research, we measured the oblique ion-induced secondary electron emission coefficient(γ) and the work functions ϕ_ω of MgO protective layer in AC coplanar type PDP. Also we has compared the oblique secondary electron emission coefficient(γ)

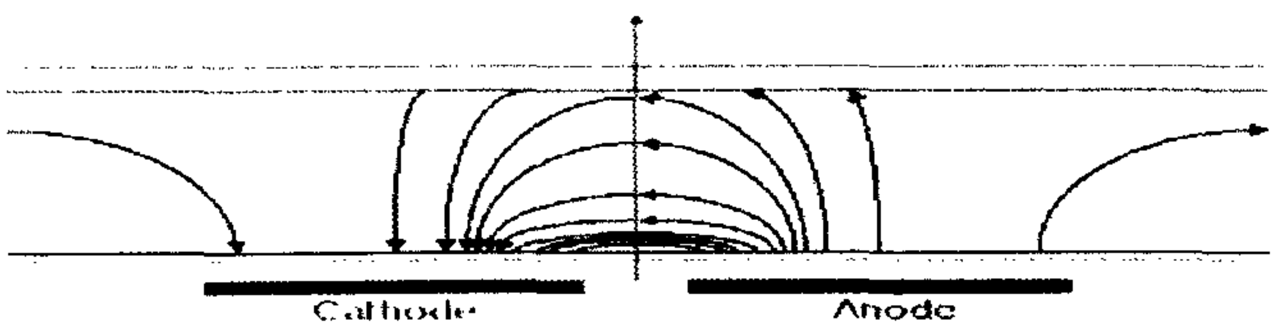


Figure 1. Electric field in the AC coplanar type PDP cell

of the MgO surface with that of normal incident ions. Also the work functions ϕ_ω of MgO protective layers with the titled angles of 10,20, and 30 degrees with respect to the vertical line, have been measured from the various ion-induced secondary electron emission coefficient in this experiment.

Experimental Configuration

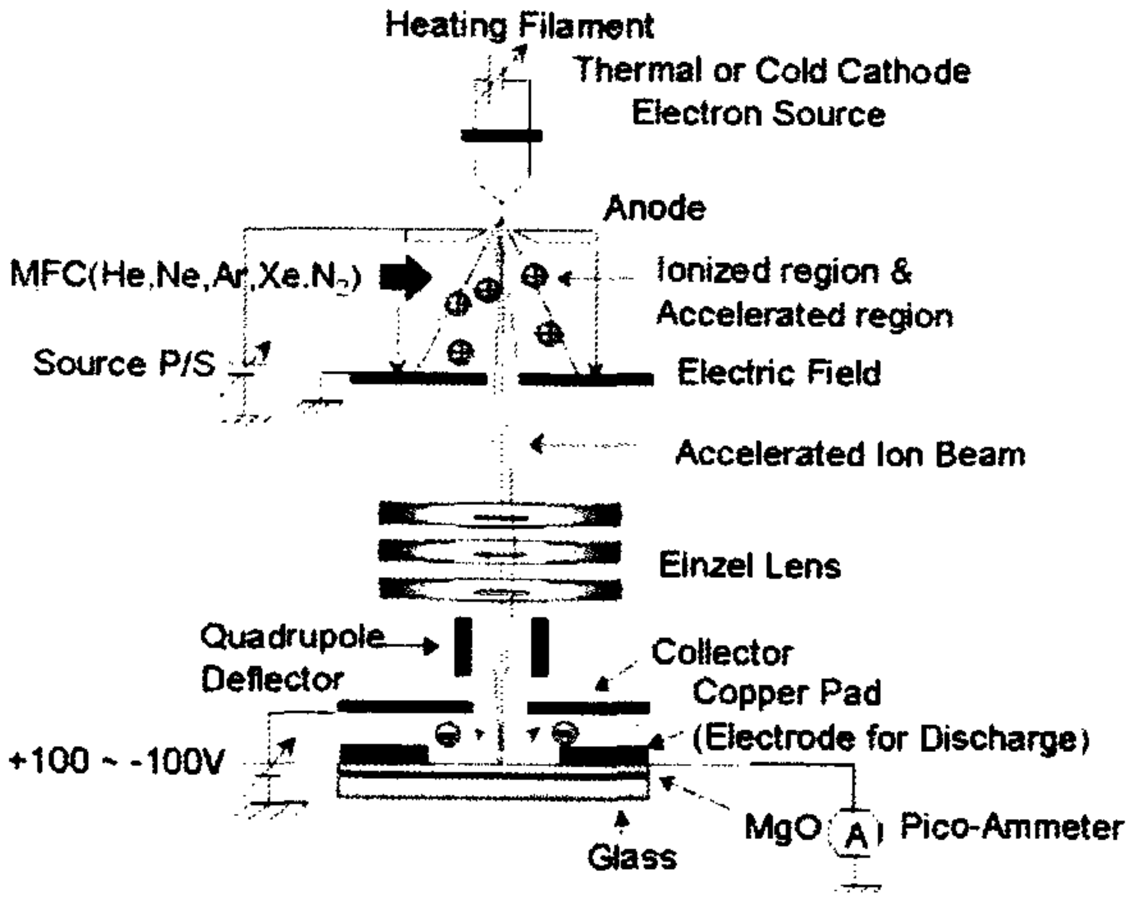


Figure 2. The schematic of γ-FIB (focused ion beam) system

The MgO protective layers are deposited on the slide glass by electron beam evaporation method and vaccum annealed it under 300 degree Celcius about 30 minutes after the sintered MgO thin film deposition. The thickness of MgO thin film is 5000 Å and the deposition ratio is 5Å/s in this experiment. He^+ ions are used whose energies are ranged from 50eV to 150eV. Oblique ion-induced secondary electron emission coefficient(γ) has been measured by γ-FIB system[6]. The γ-FIB system , as shown in Fig. 2, is broken down into five basic components: the diode consisting of thermonic electron source and anode, electron-impact ion formation and its acceleration region, electrostatic single Einzel lens for ion beam focusing, quad-pole deflector, and substrate for measurement of MgO thin film, respectively. The background vacuum pressure of γ-FIB is maintained at 1.6×10^{-5} Torr, whereas it is kept up by 7×10^{-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. The kinetic energy of ions is depended on the ion accelerating voltage applied to the anode[7]. The anode is positively biased from +50 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 focused beam diameter of 80μm throughout this experiment, which can be achieved by adjusting the filament heating current under the given ion acceleration energy. The ion induced secondary electron are emitted from the MgO surface whenever the ions strike it. However, the ion induced secondary electron return back to the surface if the collector is negatively biased Therefore, only the ion current refisters on the ampere meter connected to the copper pad. On the other hand, both the ion and ion induced secondary electron emission currents are measured by the ampere meter if the collector is at positive potential, because the ion induced secondary electron are absorbed by positive biased collector[7]. In this research, the apparatus used in this measurement is like others reported earlier[7]. The substrate is modified for the oblique ion beam in this work. Therefore, the incident ion beam has an angle of 10 degree, 20 degree and 30 degree by tilting the MgO substrate in this experiment. In this research, the ion beam has taken to be by 10 degree, 20 degree and 30 degree, and we have compared the oblique secondary electron emission coefficient(γ) of the MgO surface with that of perpendicular incident ions. Here the angle of incident ion beam angle has been set and followed by proper selection of substrate width for the bombarded ion beam to the substrate to be in collateral height. The error of the setted angle was minimized by the contacting the substrate to the stage. It is noted in this experiment that the distance from the anode to the MgO thin film surface has been kept to be same for various oblique ion beams.

Experimental Results and Discussions

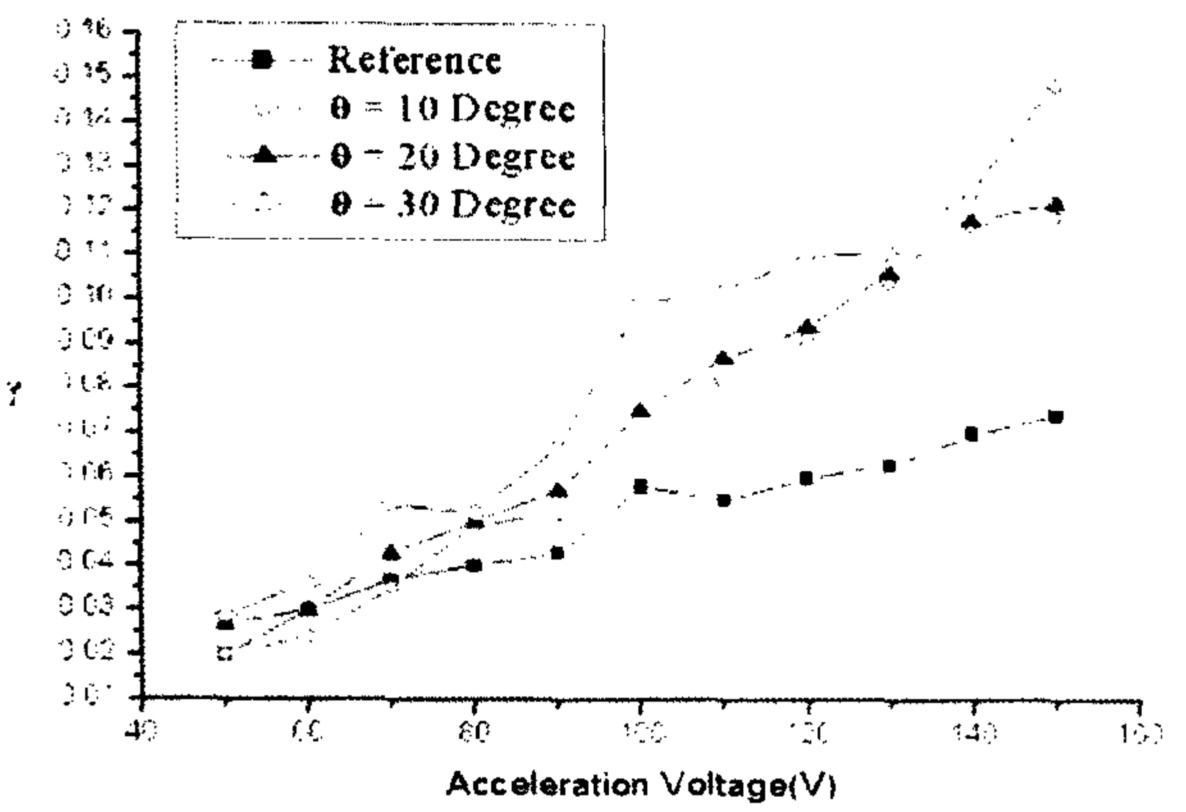
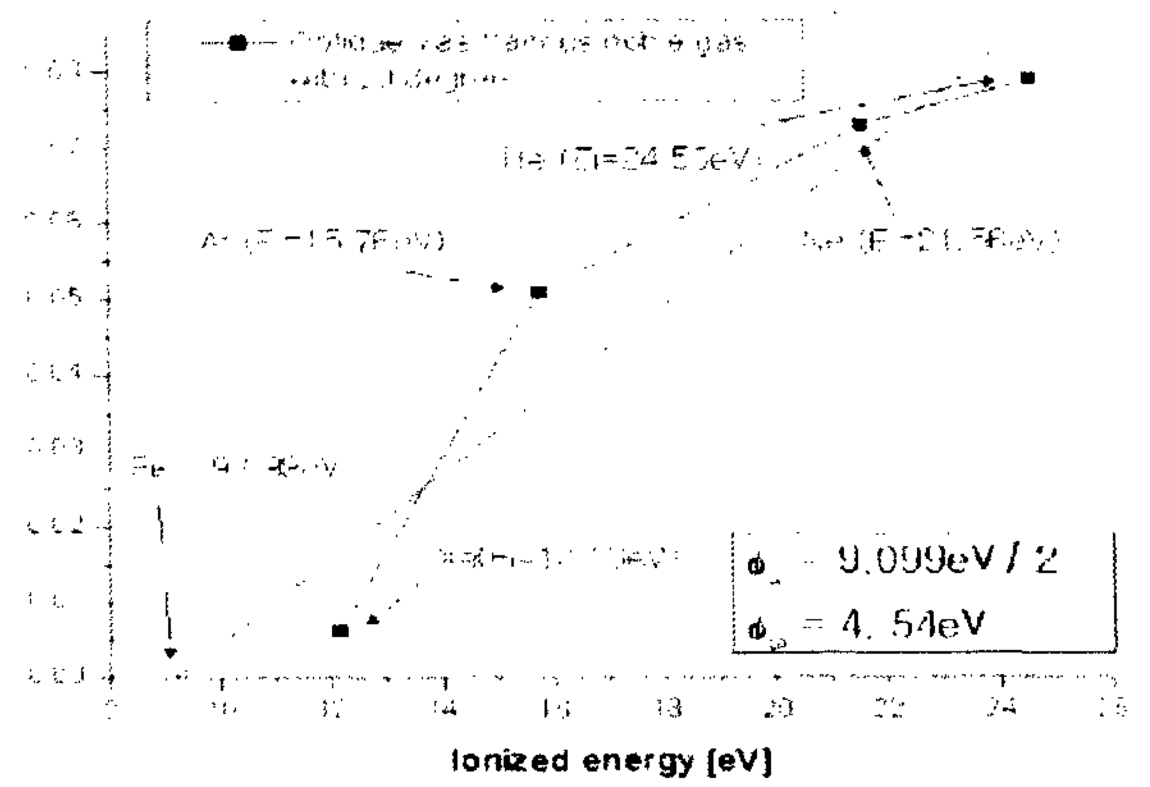


Figure 3. ion induced secondary electron emission coefficient **for the ion energies ranged from 50eV to 150eV using He Ion**

The experimental result, Fig. 3, shows the secondary electron emission coefficient obtained for sintered MgO thin film with various oblique ion beams and perpendicular incident ion beam. It is found that the higher ion-induced secondary electron emission coefficient has been obtained for the oblique ion beams than that those of normal ions. The secondary electron emission coefficient of MgO thin film for the perpendicular ion beam is shown to be from 0.02 up to 0.074, and to be from (0.02, 0.027, 0.027) up to (0.119, 0.122, 0.149) for the oblique ion beams with (10, 20, 30) degrees, respectively, for the ion energies ranged from 50eV to 150eV throughout this experiment using He ion. Also, as shown in Fig. 4, We have obtained that the work function is shown to be 5.15eV for normal ion beams and oblique work functions is 4.54eV for the oblique ion beams with 20 degrees with respect to vertical line under the 100eV ion energies throughout this experiment. For the Ne ion, incident angle on the MgO surface is reported to be around 18 degree [8]. The work function $\phi_\omega = E_{io}/2$ by oblique ion beam has been experimentally obtained from the measurement of ion induced secondary electron emission coefficient versus the various ionization energies E_i for the slow ion[7]. This experimental work-function has been obtained from 100eV.



Work function Φ_w

Reference	θ = 20 Degree
5.15eV	4.54eV

Figure 4. Work function of Reference and Oblique ion (θ = 20) for the ion energies at 100eV

Conclusion

The oblique ion beams have been approached to MgO protective layer by using the tilted MgO substrate. The MgO thin film with oblique ion beams is found that the higher ion-induced secondary electron emission coefficient has been obtained than those for that with normal ions. The secondary electron emission coefficient of MgO thin film for the perpendicular ion beam is shown to be from 0.02 up to 0.074, and to be from (0.02, 0.027, 0.027) up to (0.119, 0.122, 0.149) for the oblique ion beams with (10, 20, 30) degrees, respectively, for the ion energies ranged from 50eV to 150eV throughout this experiment. Also, We have obtained that the normal work function is shown to be 5.15eV for normal ion beams and oblique work functions is 4.54eV for the oblique ion beams with 20 degrees with respect to vertical line under the 100eV ion energies throughout this experiment. This experiment data could furnish basic data for the oblique incident ion beam-induced secondary electron emission coefficient from the MgO thin film in the plasma display panel.

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