Influence of gas mixture ratio on the secondary electron emission coefficient (γ) fo MgO single crystals and MgO protective layer in AC PDP

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The secondary electron emission coefficient γ of MgO single crystal according to the gas mixture ratio of Xe, N_2 to Ne have been investigated by γ–focused ion beam system. It is found that the MgO single crystals of (111) crystallinity has the highest γ for operating Ne(Xe) ions ranging from 50eV to 200eV throughout this experiment. And it is found that the γ for gas mixtures are much smaller than pure Ne ions.

Keywords : secondary electron emission coefficient, MgO, crystallinity, gas mixture

1. Introduction

The secondary electron emission coefficient γ of a MgO protective layer in AC plasma display panel(AC-PDP) is an important factor to determine firing voltage and sustain voltage. The MgO films have important role in lowering the firing voltage[1] due to a high γ. Recently it is reported that (111) crystallinity of MgO protective layer has the highest γ in comparision with other layers with orientation of (200) and (220)[2]. For clarification and verification of this result, it is of great importance to investigate the γ of MgO single crystals at first before various deposited MgO films characteristics are extensively discussed among PDP people.

2. Experimental Configuration

The MgO single crystals of (111), (200), (220) are used for measurement of γ in γ-FIB system. Their sizes are 10mm x 10mm and 0.2mm in thickness. In this experiment, Ne, Xe ions and N_2 as well as their mixtures are used for the measurement of γ. It is of great importance to investigate the γ from MgO single crystals and MgO protective layer in real AC-PDP with various gas mixtures ratio of Xe, N_2 to Ne buffer gas. The real AC-PDP front panel size is 35mm x 35mm and 3.5mmin thickness. The MgO protective layer is deposited on the dielectric layer by electron beam evaporation method and its thickness is about 5000Å.

3. Experimental Results and Discussions

Figure 1 shows the γ obtained for MgO single crystals of (111), (200), and (220), which are characterized by solid squares, solid circles, and solid triangles, respectively, versus Ne ion accelerating voltage from 50V up to 200V. The single crystallinity (111) is found to have the highest γ from 0.09 up to 0.16, while from 0.07 up to 0.15 for (200) and from 0.06 to 0.13 for (220) crystallinity for operating Ne ions ranging from 50V to 200V throuout this experiment.

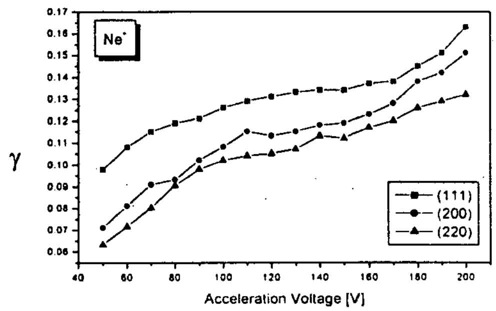

Fig.1 γ from various MgO single crystals versus Ne ion acceleration voltage

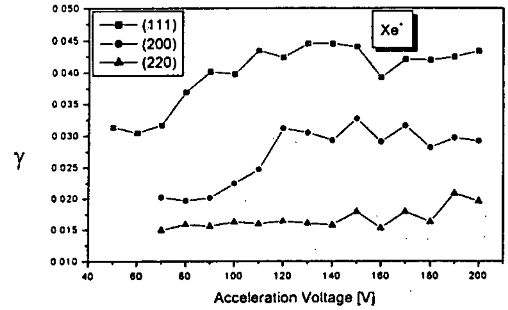

Fig.2 γ from various MgO single crystals versus Xe ion acceleration voltage

Figure 2 shows the similer results to figure 1 for Xe ions. The MgO single crystals of (111) orientation is also found to have the highest γ from 0.03 up to 0.04, while from 0.02 to 0.03 for (200) and from 0.01 to 0.02 for (220) crystallinity, respectively.

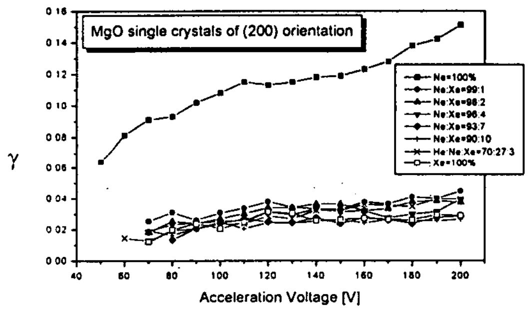

Fig.3 γ from MgO single crysrals of (200) orientation for the Ne, Xe and their various mixture versus ion accelerating volrage

Figure 3 shows the γ from MgO single crystals of (200) orientation for the pure Ne, Xe, and their various mixtures versus ion accelerating voltage ranged from 50V to 200V. In this experiment, the gas mixture ratio of Ne:Xe are 99:1, 98:2, 96:4, 93:7, and 90:10. The γ for pure Ne and Xe ions also represented by solid squares and open squares, respectively, in figure 3. It is noted that the γ ranged from 0.01 up to 0.04 for Ne-Xe gas mixtures are shown to be much smaller than those ranged from 0.06 up to 0.15 for pure Ne ions at above ion energy ranges. It is found that the γ for Ne-Xe gas mixtures are very close to those for pure Xe ions at above ion energy ranges, because most ions are Xe spieces rather than Ne ions due to low ionization energy of Xe.

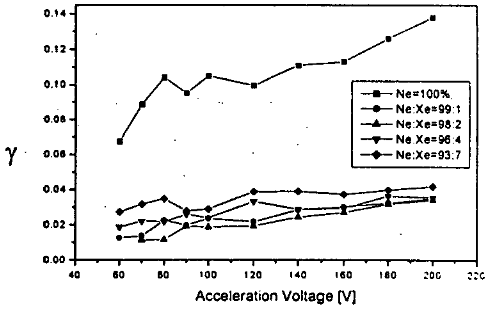

Fig.4 γ from MgO protective layer in AC-PDP with different mixture ratio of Xe to Ne versus ion acceleration voltage

Figure 4 shows the results of γ from MgO protective layer in real AC-PDP with different gas mixture ratios of Xe to Ne versus ion acceleration voltage 60V up to 200V. It is also noted that γ ranged from 0.01 up to 0.05 for Ne-Xe gas mixtures are much smaller than those ranged from 0.07 up to 0.14 for pure Ne at above ion energy range. It is noted that the γ from MgO protective layer in real AC-PDP for various Ne-Xe gas mixtures are very similar to those in figure 3.

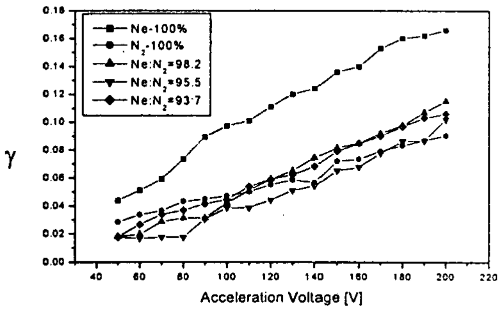

Fig.5 γ from MgO single crysrals of (200) orientation for the Ne, N_2 and their various mixture versus ion accelerating volrage

Figure 5 shows the γ from MgO single crystals of (100) orientation for the pure Ne, N_2, and their various mixtures versus ion accelerating voltage ranged from 50V to 200V. In this experiment, the gas mixture ratio of Ne:N_2 are 98:2, 95:5, and 93:7. The γ for pure Ne ions and N_2 also represented by solid squares and solid circles, respectively, in figure 5. It is noted that the γ ranged from 0.02 up to 0.11 for Ne-N_2 gas mixtures are shown to be smaller than those ranged from 0.06 up to 0.15 for pure Ne ions at above ion energy ranges. It is found that the γ for Ne-N_2 gas mixtures are very close to those for pure N_2 ions at above ion energy ranges, because most ions are N_2 spieces rather than Ne ions due to low ionization energy of N_2.

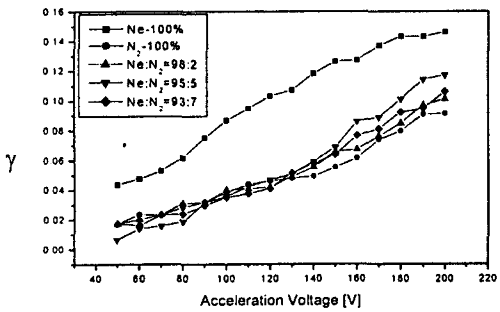

Fig.6 γ from MgO protective layer in AC-PDP with different mixture ratio of N_2 to Ne versus ion acceleration voltage

Figure 6 shows the results of γ from MgO protective layer in real AC-PDP with different gas mixture ratios of N_2 to Ne versus ion acceleration voltage 50V up to 200V. It is also noted that γ ranged from 0.01 up to 0.11 for Ne-N_2 gas mixtures are much smaller than those ranged from 0.04 up to 0.15 for pure Ne at above ion energy range. It is noted that the γ from MgO protective layer in real AC-PDP for various Ne-N_2 gas mixtures are very similar to those in figure 5.

4. Conclusion

The secondary electron emission coefficient γ of MgO single crystals and MgO protective layer in real AC-PDP have been investigated by γ-focused ion beam system. The single crystallinity (111) is found to have the highest γ from 0.03 up to 0.04, while from 0.02 to 0.03 for (200) and from 0.01 to 0.02 for (220) crystallinity for operating Xe ions ranging from 50eV to 200eV throuout this experiment. Based on these fact, it can be concluded that (111) crystallinity in MgO protective layer plays an important role in lowering the firing voltage in AC-PDP compared with the other crysrallinities of (200) and (220). The γ for Ne-Xe gas mixtures are shown to be much smaller than those for pure Ne· ions for accelerating voltages from 50V to 200V. The γ for the Ne-Xe gas mitures has been approached to those for pure Xe ions since most ions are Xe species rather than the Ne ions due to low ionization energy of Xe. Also the γ for Ne-N_2 gas mixtures are shown to be smaller than those for pure Ne ions for accelerating voltages from 50V to 200V. The γ for the Ne-N_2 gas mitures has been approached to those for pure N_2 ions since most ions are N_2 species rather than the Ne ions due to low ionization energy of N_2.

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