Field Emission Characteristics of an Oxidized Porous Polysilicon Field Emitter Using Dielectric Layer as a Passivation

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There have been various flat panel displays (FPD’s) designed to overcome the limitations of a conventional cathode ray tube. Field emission displays are drawing attention as one of the most promising flat-panel displays due to a clear image and wide viewing angle[1,2]. The oxidized porous poly silicon (OPPS) was proposed as the most promising candidate for field emission displays owing to its simple fabrication process, vertical and low voltage emission characteristics[3]. However, the OPPS needs to be investigated to extend the time of steady emission because the upper electrode suffers from degeneration due to Jule’s heat. Therefore, in this paper, we investigated the field emission characteristics of the OPPS emitter with dielectric layer which can improve the time of steady emission.

The polysilicon layer with a thickness of 1.75 μm was deposited on the 7 lines patterned n+ doped p-type (100) silicon substrate using low-pressure chemical-vapor deposition (LPCVD) method. Then anodized in HF(49%): ethanol = 1:1 solution at current density of 10 mA/cm² for 15 seconds[4]. After anodization, samples were oxidized at a temperature of 900°C for 60 min. After that the WO₃ as a dielectric layer was deposited 7 lines using RF sputter with a thickness of 2 nm/7 nm. Last, the Ti/Pt upper electrode was deposited 7 line using DC sputter with a thickness of 2 nm/7 nm. The bias voltage Vps was applied to the top Ti/Pt electrode and the anode voltage V_A above the Pt electrode was kept at a positive potential to collect the emitted electrons.

The emission efficiency was investigated in a high vacuum chamber. Figure 1 shows the relationships among the current flow through the OPPS layer(Ips), the emitted current(Ie), the emission efficiency and the time of steady emission without dielectric layer. The applied voltage to the top Pt electrode varied from 0 V to 20 V. The emission efficiency increases with increasing Vps and the emission efficiency is saturated 0.19 % at Vps=20 V. The time of steady emission is dramatically decreased at 7.5 min at Vps=20 V because of degeneration of the upper electrode. Figure 2 shows the relationships among the current flow through the OPPS layer(Ips) and the emitted current(Ie), the emission efficiency and the time of steady emission with dielectric layer. The current flow(Ips) is quite similar with Ti/Pt upper electrode whereas emitted current(Ie) is lower than one because the dielectric layer conducted like a barrier. Therefore the efficiency is 0.06% at 20V which is quite lower than the Ti/Pt upper electrode. However, the time of steady emission was saturated after 7.5 min compared with Ti/Pt upper electrode.

We investigated the electron emission characteristics of the OPPS emitters with dielectric layer. We confined that dielectric layer conducted like a passivation layer even though the efficiency was slightly decreased. Accordingly, the OPPS emitters with dielectric layer will be sufficiently applicable to high quality field emission display devices.

References