The Influence of Dry Etching Process by Charged Static Electricity on LCD Glass

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Abstract

We verified the charged static electricity on LCD glass influences upon the etching uniformity of dry etching process by plasma. In the TFT-LCD manufacturing process, we mainly paid attention to eliminate the static electricity for TFT reliability. The static electricity caused the serious ununiformity of etching surface profile and etching rate in the dry etch process. Through our experiment on the made static electricity from -200V to -1000V, it was confirmed that the static electricity on LCD glass caused the etching rate variation of 1.5%~15%. We recommend the etching process equipment for LCD manufacturing have to establish the soft X-ray exposure module system for eliminating the static electricity inside the loading and unloading chamber.

Introduction

LCD glass panel can easily be charged a high electric potential until several kVs by the static electricity when it is handled in the manufacturing process. The static electricity has mainly two impediments on the manufacturing process. One is the statically charged glass surface is contaminated with drafting particles which are absorbed by the electrostatic force. The other is TFT is destroyed by electrostatic discharge [1][2][3][4].

Besides, we know the static electricity causes the serious ununiformity of etching surface profile and etching rate in the dry etch process. Also, in CVD process, it is regarded affecting the deposition rate. It must be considered that the static electricity directly affects the process characteristic in the TFT-LCD manufacturing process.

Experimental Process

The used plasma etcher is for 300 × 350mm^2 LCD glass (Japan PSC Co, DES-A325E). It is mainly used for a-Si and Ta etching process in manufacturing line. This is the parallel plate type to have anisotropic etching characteristic.

For the experiment, two kinds of LCD glass samples were prepared. The sizes of them were 10 × 10cm^2 and 2 × 3cm^2 respectively. On the glass samples, a-Si layers had been deposited to 1000Å by LPCVD. Because of two kinds of glass samples' size, two kinds of Al-meshes were prepared for artificially making the static electricity. They were the same size with glass samples. The pattern of Al-mesh was made by hexagonal holes like a honeycomb. To make the static electricity, the Al-mesh was contacted under the glass sample.

In the experimental procedure, first, the each sample was fixed on 300 × 350mm^2 LCD glass panel. Second, the naturally made static electricity on the samples was completely eliminated by soft X-rays exposure[5]. Third, samples were artificially charged from -200V to -1000V through the contact of the Al-meshes. Finally, samples were transferred to the reaction chamber by the robot arm for dry etch process.

Before the experiment, we measured natural disappearance of the artificially made static electricity on the sample according to the time. It was confirmed the static electricity was naturally disappeared from initial value to 60%~70% value during transfer from cassette to reaction chamber.

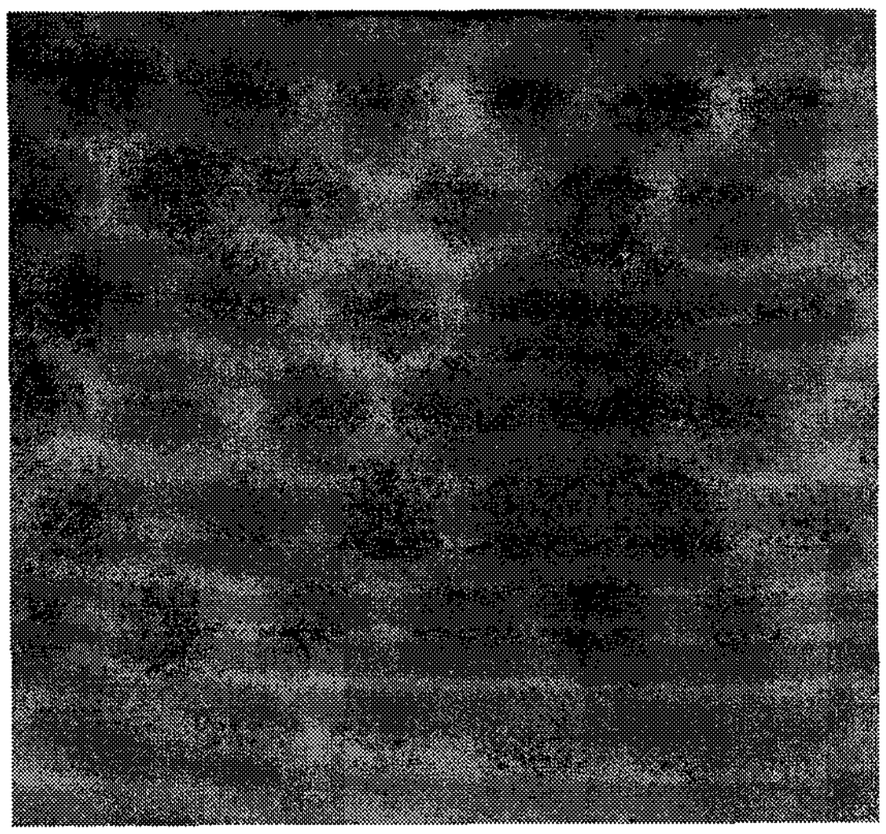

Figure 1. The LCD glass surface pattern after etching process (charged static electricity : -1kV, sample size : 10 × 10 cm^2)

The conditions of etching process were total pressure 60mTorr, flow rate of SF_6 50sccm, RF power 300W, RF time 20 seconds and electrodes spacing 50mm.

Results and Discussion

Figure 1 shows the etching process result of charged glass surface. The pattern of charged static electricity was reappeared on the glass. This sample was charged about −1kV. The sample size was 10 x 10 cm^2. The white area in the Figure 1 was the charged area. It was measured this area had a high etching rate.

Figure 2 shows the glass surface etching pattern by the static electricity of supplied potential. The Al-mesh for artificial charging had two jointed hexagonal holes like a honeycomb. The etching surface pattern on the glass sample was same with the Al-mesh pattern. The samples were charged to (a): -200V, (b): -400V, (c): -600V, (d): -800V and (e): -1000V, respectively. All of five samples' size were 2 x 3 cm^2. The etching process condition was same with Figure 1. The black area in Figure 2 was the charged area, and had a high etching rate.

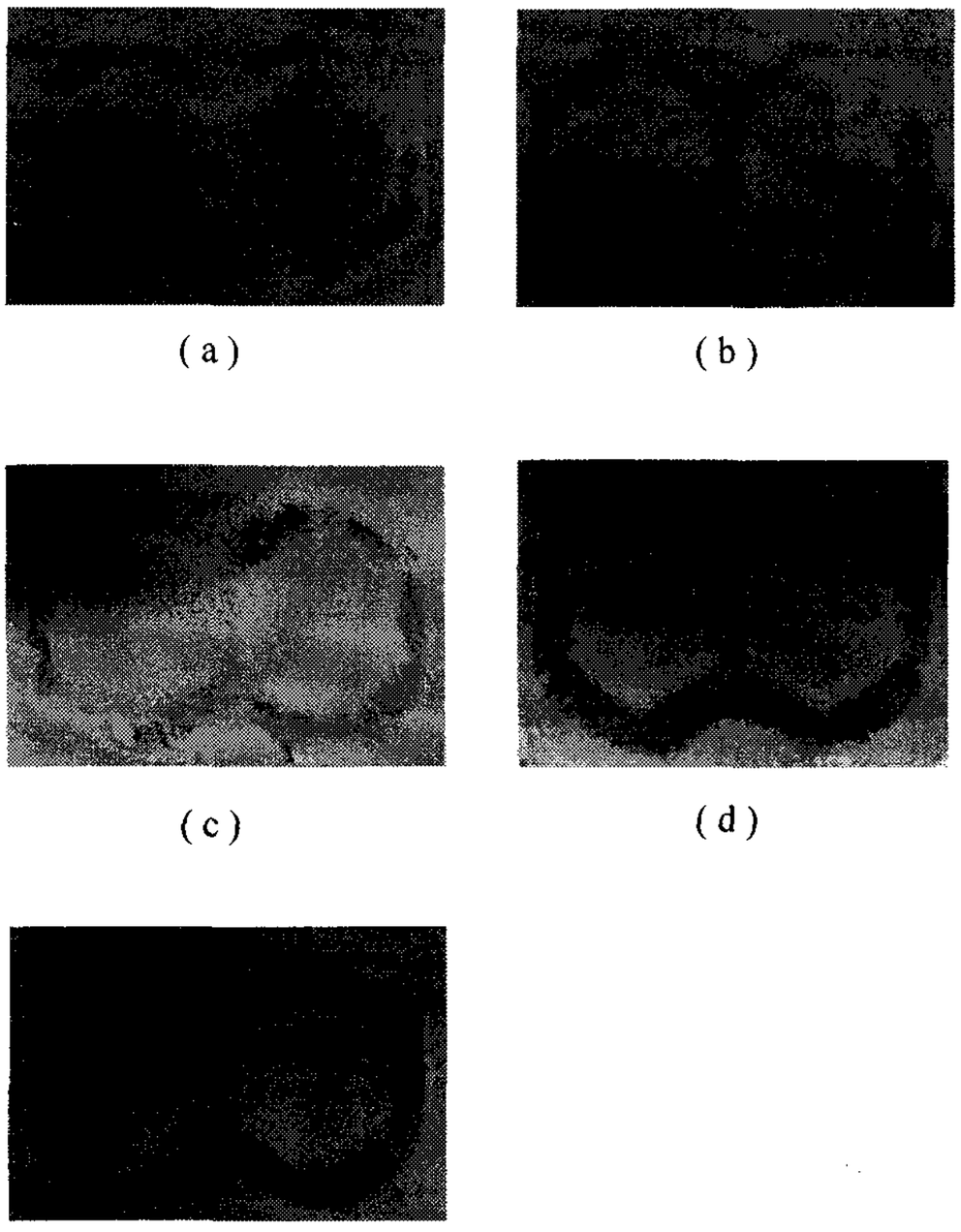

Figure 2. The LCD glass surface pattern by supplied static electricity. { (a) : -200V, (b) : -400V, (c) :-600V, (d): -800V, (e): -1000V, sample size: 2 × 3cm^2 }

The comparison of etching rates between charged area and non-charged area is shown in Figure 3. These data were measured from Figure 2. Non-charged areas of each sample had lower etching rates than charged areas. These values were nearly same without relation to supplied charging values. On the other hand, charged areas had higher etching rates than non-charged areas. The etching rates of these areas were increased according to supplied electrostatic potentials.

From the experimental result, when the static electricity was charged from -200V to -1000V on glass samples, it was confirmed that the etching rate was changed to 1.5%～15% in charged areas.

As the reason of these data, the electrostatic force is naturally generated on the LCD glass by the negative supplied electrostatic potential. As the negative electrostatic force more accelerates ionized atoms during the plasma forward samples, we think charged area has more high etching rate than non-charged area.

Conclusion

We confirmed that the charged static electricity on LCD glass affected the dry etch process. Through our experiment on the made static electricity, it was verified that the static electricity on LCD glass caused the etching rate variation of 1.5%～15%. In the TFT-LCD manufacturing process, the static electricity problem should be considered.

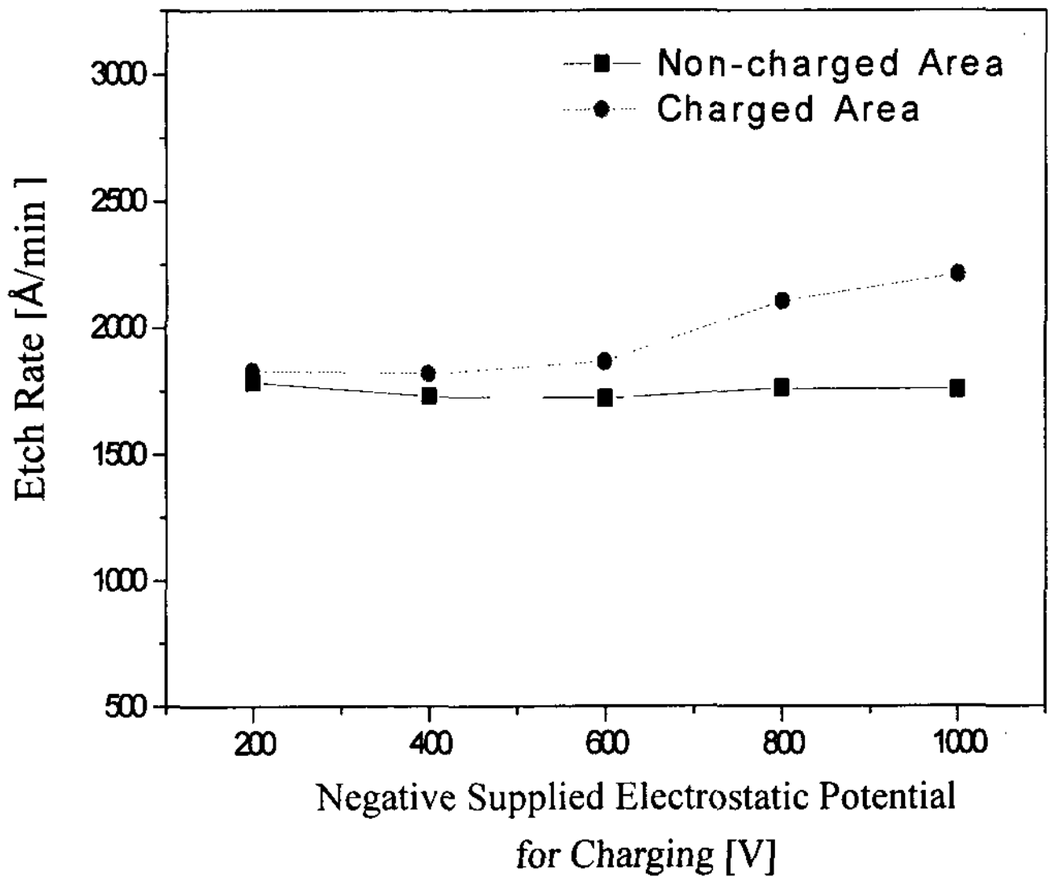

Figure 3. The comparison of etch rates between charged area and non-charged area

As the charged static electricity on the insulating material such as LCD glass can not be easily eliminated, in order to actualize more stable etching process, the development of more complete anti-static process is required. We recommend the etching process equipment for LCD manufacturing have to establish the soft X-ray exposure module system for settling the static electricity problem inside the loading and unloading chamber.

In the next time, the mechanism of etching characteristic by this problem will be examined in detail. Also, this problem will be estimated in another layers except a-Si in the LCD process. In CVD process, we are also going to test how the static electricity will affect the deposition rate.

References

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