The effects of buffered oxide etch cleaning on the electrical characteristics of eximer laser annealed polycrystalline silicon thin film transistor

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Until the present time, most of the switching device of the TFT-LCDs were produced by a-Si:H(amorphous silicon). But due to increase of demand on more thin and light TFT-LCDs, a technique to manufacture TFT-LCDs using polycrystalline silicon is under way.[1,2]

If we make the device of TFT-LCDs using polycrystalline silicon, driver IC can be integrated on the same glass substrate because the mobility of carriers increases about 100 times higher than that of amorphous silicon. With this result we can produce more thin and light TFT-LCDs. Recently, eximer laser annealing is the most influential candidate for the crystallization of the amorphous silicon due to its large grain size and high carrier mobility. But in the step of crystallization, the reliability of device declined because of grain boundary protrusion due to the surface oxide, which resulted in the variation of threshold voltage and the increase of leakage current.[3]

In this study, we developed a technique to manufacture more reliable polycrystalline silicon TFT-LCDs using UV cleaning and buffered oxide etch(BOE) cleaning which remove the native oxide of the silicon surface before laser annealing. To investigate the effects of pre-treatments on the surface roughness of polycrystalline silicon, we measured atomic force microscopy(AFM). And the electrical characteristics of polysilicon TFTs, breakdown characteristic and switching performance, were test for various pre-treatment conditions and several locations in large glass substrate.

Fig. 1 shows the surface protrusion of laser annealed polysilicon thin film. Fig. 2(a) shows the AFM image of polysilicon pre-treated using UV and BOE cleaning and annealed at N_2 atmosphere, which shows average roughness of 489Å. This result showed smoother surface than any other pretreatment conditions.

To investigate the effects of BOE cleaning on the electrical charactersics of polysilicon TFT, we fabricated the coplanar TFT and measured the gate leakage current with increasing the gate voltage. Fig. 3 shows the gate leakage current at various pre-treatment conditions. TFTs annealed at air and N_2 atmosphere without pre-treatment had a breakdown point above 90V, but there were no breakdown points for other TFT samples. Fig. 4 shows the switching curve of three TFTs when Vd is 1 and 10V. Without BOE pre-treatment(in Fig. 4(b)), the increase of leakage current and the shift of threshold voltage were observed after stressed at Vg = -60V/60sec.

In conclusion, we applied a BOE cleaning process to pre-treatment for eximer laser annealing and could obtain smoother surface morphology. For the BOE cleaned polysilicon TFTs, the electrical breakdown characteristics were improved and leakage current and threshold voltage shift were minimized.

References

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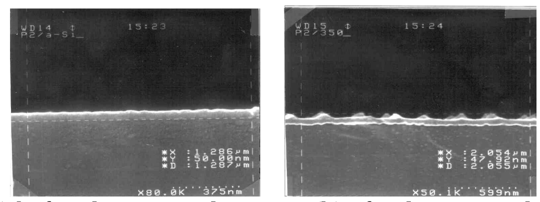
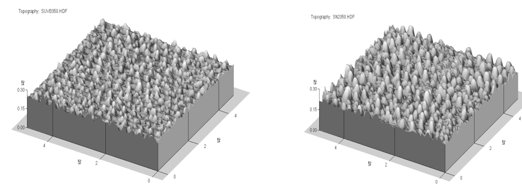


(a) before laser annealing (b) after laser annealing

Fig. 1. The surface protrusion after eximer laser annealing.



(a) UV+BOE+N_2(Ravg : 489Å) (b) None + N_2(Ravg : 744Å)

Fig. 2.The surface roughness of laser annealed polysilicon for pre-treatment conditions.

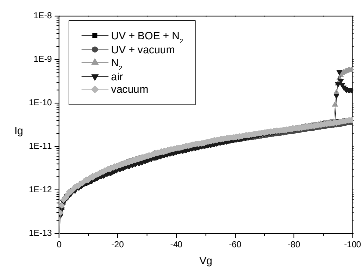
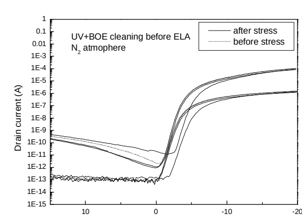
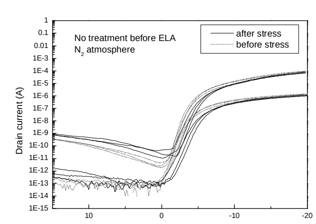


Fig. 3. Ig-Vg characteristic curves for various pre-treatment conditions.



(a) UV + BOE + N_2,



(b) None + N_2

Fig. 4. The switching performance of TFTs at stressed condition. (Vd = 1, 10V)