Increase in Photoconductivity of Silicon Films after BLDA by Back-Reflection Ti Layer for System on Glass

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Multifunctional displays with System on Glass (SoG) have drawn high attention recently due to the high performance and low cost capabilities. So far, high-performance TFT characteristics have been obtained by using Blue Multi Laser Diode Annealing (BLDA) in our group [1]. In terms of realizing SoG, high-performance TFT system with low cost can be possible by integrating sensors with TFTs on a same panel by fabricating the identical process. However, light energy especially in red and infrared region cannot be absorbed enough into thin Si film (50 ~ 100 nm) due to high transmittance. In order to improve photosensitivity, multi-layer structure was proposed, using Ti as a metal back-reflection layer (Fig.1) [2].

Ti was deposited on glass substrate using vacuum evaporation. SiO_2 of 240 nm thickness as a buffer layer and Si layer of 50 nm thickness were deposited on the Ti film at room temperature by RF sputtering. Si layer was deposited using Ne as a sputtering gas [3]. The Si films were crystallized using BLDA at 5 W with a beam of 600 × 2.4 μm^2 at a scanning speed of 500 mm/s. BLDA is reported as a new alternate to Excimer Laser Annealing (ELA). Furthermore, additional hydrogen annealing was carried out at 450˚C for 60 min in H_2/N_2 (4%) to improve photosensitivity by terminating the dangling bonds existing at the grain boundaries or the small defects in the Si film. Si films were patterned with L/W = 50 μm/100 μm for the light absorption area (Fig.2). Photocurrent measurement was carried out under white light exposure of 100 mW/cm^2.

Fig.3 shows a result of X-ray diffraction (XRD) analysis for the Si films with underlying Ti layer after BLDA at 5 W. Peak of (111) for Si was observed in the vicinity of 28°. Moreover, since the peak is also confirmed in (110) and (311) angles, Si film is believed to be poly-crystallized. Fig.4 shows, photosensitivity (the ratio: $\sigma_{photo}/\sigma_{dark}$) of 5.1 was obtained with the fine patterned a-Si film, at 10 V bias due to the improvement of light absorption by preparing a back-reflection layer. Furthermore, as a result of hydrogen annealing, photosensitivity was improved to about 10.3 due to the improvement of lifetime (τ) and mobility (μ) for carriers by terminating the dangling bonds existing at the grain boundaries or the small defects in Si film. However, the dark conductivity was increased. It is speculated that the leakage current was increased due to the partial leak to Ti through SiO_2 layer, or reduction in the defects density in the Si films. Further studies are required.

In summary, Ti back-reflection layer was effective to improve the photosensitivity. Furthermore, photosensitivity was improved after hydrogen annealing. Multi-layer films structure of photosensor is expected to be applied to high-functional smart panel system.

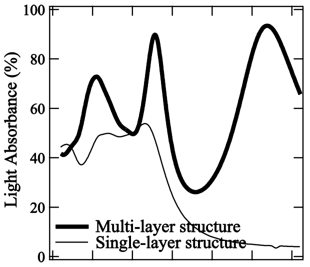

Fig.1 light absorbance for multi-layer structure

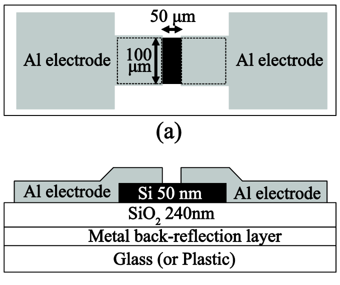

Fig.2 (a) Top and (b) side view of multi-layer structure of photosensor

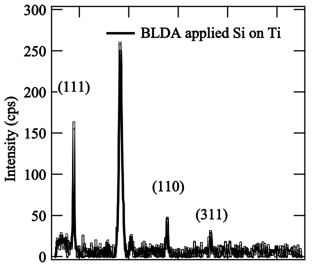

Fig.3 XRD spectra of Si film after BLDA.

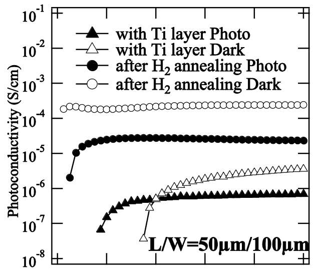

Fig.4 Photo- and dark-conductivity characteristics before and after hydrogenation

References

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