

Effect of Low Temperature Annealing of Sputtered SiO₂ for Gate Insulator in Poly-Si TFTs

Hikaru Tamashiro, Kimihiko Imura, Tatsuya Okada and Takashi Noguchi

Faculty of Engineering, University of the Ryukyus,

1 Senbaru, Nishihara, Okinawa 903-0213, Japan

Tel.: +81-98-895-8680, E-mail: k158533@eve.u-ryukyu.ac.jp

Poly-Si Thin Film Transistors (TFTs) are used for displays of TV panels or smartphones. High quality gate insulating film with high breakdown voltage at low leakage current is required. Insulation strength of the gate oxide film can be realized by adding small amount of oxygen during deposition by sputtering and improvement in poly-Si TFT characteristics by hydrogen annealing at low temperature has been reported [1, 2]. It is considered that the defects density in SiO₂ film and at Si/SiO₂ interface are reduced by hydrogen annealing. However, the influence of hydrogen on sputtered SiO₂ film as a gate oxide has not been understood yet in detail.

For Al / SiO₂ structure, the post metallization annealing (PMA) is known in the SiO₂ film deposited by chemical vapor deposition (CVD). Al electrode reacts with H₂O or OH of the SiO₂ Film when annealing at 400 °C. Dangling bonds are terminated by the generated hydrogen atoms [3].

SiO₂ film was deposited by radio frequency (RF) sputtering on p type Si substrate (4~10 Ωcm). Al electrodes were formed on the surface (0.5 mm φ) and on the back-surface. The SiO₂ film was annealed at 400°C for 30 min in H₂/N₂ (4%) ambient. Fig.1 shows leak current before and after hydrogen annealing. Fig.2 shows C-V characteristics at high frequency of 100 kHz before and after the hydrogen annealing. As is shown, hysteresis decreased down to 5×10⁻¹⁰ A/cm² by performing the hydrogen annealing after the Al electrode formation. The result suggests that the dangling bonds at the SiO₂ film surface are terminated with hydrogen atoms. It is estimated that PMA acts effectively even for the sputtered SiO₂ film. Furthermore, after the annealing, the flat-band voltage shifted to ideal level of -0.9V from C-V characteristics. Reduced of leak current and shift of the flat band voltage to suggest that dangling bonds in the SiO₂ film were terminated effectively.

From these results, insulating characteristics of the SiO₂ film are considered to be improved by hydrogen annealing after the formation of Al electrodes. It is expected that practical poly Si TFT performance on glass should be improved stably.

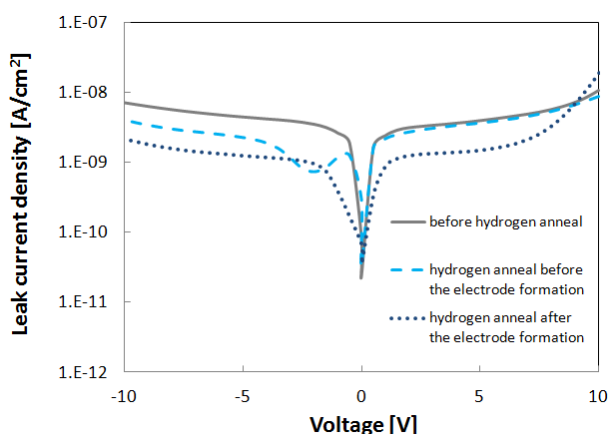


Fig.1 Leak current before and after the hydrogen annealing.

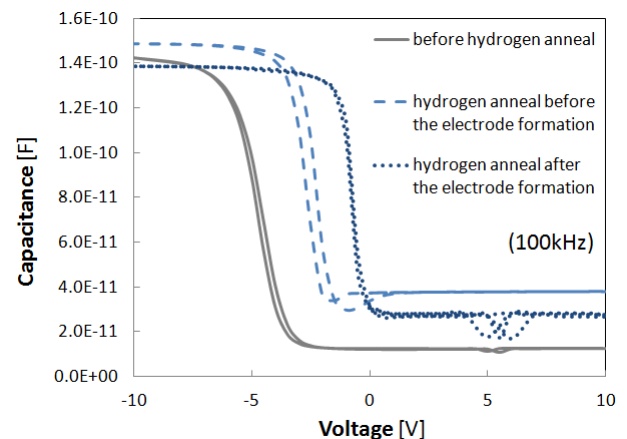


Fig.2 High frequency C-V characteristics before and after the hydrogen annealing.

Reference

1. K. Imura, T. Okada, K. Shimoda, K. Sugihara, T. Noguchi, and B.S. Bae, Proc. of IMID 14, P1-44, 2014.
2. T. Ashitomi, K. Sugihara, K. Shimoda, T. Okada, T. Noguchi, T. Miyashita, Y. Kusuda, and S. Motoyama, Proc. of IMID 14, P1-48, 2014.
3. B. Chapman : Glow discharge processes : Sputtering and plasma etching, John Wiley & Sons (1980) p.782~785