Characterization and Optimization of Plasma-Enhanced Chemical Vapor Deposited SiO₂ Film as a Hydrogen Diffusion Barrier in Metal Oxide Thin-Film Transistors

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It is well-known that the hydrogen is acting as a shallow donor in metal oxide semiconductors such as ZnO¹ or InGaZnO and actually hydrogen plasma treatment², hydrogen diffusion³ from PECVD SiNₓ film or hydrogen ion implantation⁴ into the metal oxide are sometimes utilized to lower the active resistance in the junction area for the source-drain metallization, especially in the self-align process. SiNₓ film is a good barrier against alkali ion migration or water permeation so that it can be used as a passivation film to avoid environmental effects and increase the shelf life of the products. But, PECVD SiNₓ film using SiH₄ and NH₃ gas precursor usually contain about 20 at. % of hydrogen⁵. Therefore we should use good hydrogen diffusion barrier in order to use SiNₓ film as a passivation layer of metal oxide TFT. In this study, we optimized the process parameters of PECVD SiO₂ film to use it as a diffusion barrier of hydrogen coming from upper SiNₓ 200 nm. As shown in Fig. 1, we find that the SiO₂ 50 nm deposited at high pressure exhibits good barrier performance even at 350 °C annealing for 2hrs without making IGZO TFT conductive, while SiO₂ 50 film deposited at low pressure permits some hydrogen to enter into the IGZO from SiNₓ so that the Vᵣᵢ of IGZO TFT becomes negative or the switching behavior disappears at the current gate bias range.

Fig. 1. Transfer curves of a-IGZO Etch Stopper TFTs with SiO₂/SiNₓ double passivation layer structures.

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References