Low Temperature Fabrication of High Pressure Activated In-Ga-Zn-O Thin Film Transistors

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Amorphous oxide semiconductor thin film transistors (AOS-TFTs) have been extensively researched to be adopted in backplanes for the next-generation flexible displays because of their high field effect mobility, transparency to visible light, uniform deposition, and capability of large area [1]. However, there is a restriction for AOS-TFTs to be applied on the various flexible substrates such as polycarbonate, polyethylene terephthalate, and polyethylene naphthalate which have low melting point, since the temperature above 300 ^{o}C is required to activate the channel layer of AOS-TFTs. In this study, we suggested a new method which is named as high pressure annealing (HPA) to reduce the activation temperature. Conventionally, HPA has been studied to improve the electrical performances of AOS-TFTs such as mobility and electrical stability in solution and vacuum processes. Although HPA is usually utilized to ameliorate electrical performances of AOS-TFTs, it is not considered as an energy source to activate the channel layer. Thus, we investigated the functions of HPA not only as a method to improve electrical stability under positive bias stress (PBS) test but also an energy source to activate amorphous indium gallium zinc oxide (a-IGZO) channel layer at 100^{o}C under N_2 and O_2 gases. The HPA-activated channel of a-IGZO TFTs is accomplished under N_2 40 atm and O_2 20 atm at 100^{o}C. In accordance of gas kinetic theory, the kinetic energy of gases could be converted to thermal energy which assists a-IGZO channel layer to be activated. Compared with the HPA activated a-IGZO TFTs under N_2 gas, those under O_2 gas require a lower pressure to be activated and have a higher PBS stability. It could be explained that there are more metal oxide bonds acting as current path with reduction of oxygen vacancies in HPA activated a-IGZO channel layer under O_2 gas [2]. By this research, we could find the optimal condition to activate the channel of a-IGZO TFTs with superior electrical performances and PBS stability under O_2 20 atm at 100^{o}C. Consequently, we could suggest the feasibility of activating the AOS-TFTs based on various flexible substrates at low temperature.

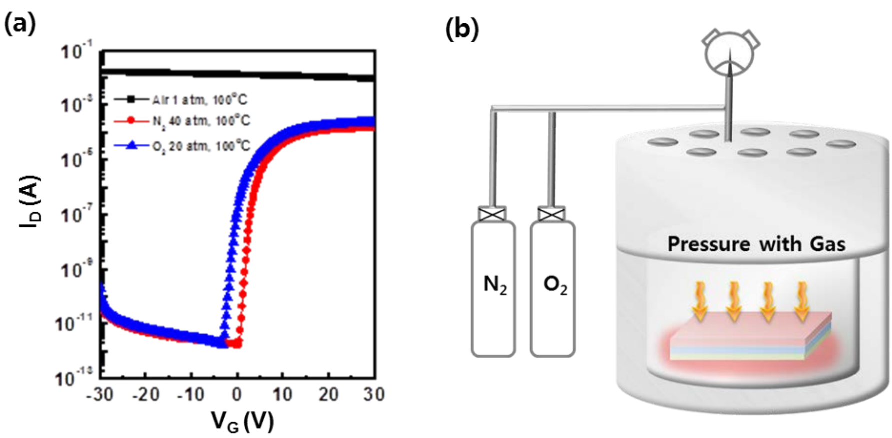

Fig. 1. (a) Comparison of transfer characteristics for HPA activated a-IGZO TFTs under 1 atm (air), 40 atm (N_2), and 20 atm (O_2) at 100 ^{o}C (b) Schematic HPA process for activation of a-IGZO channel layer.

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References

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