High performance zinc-tin-oxide thin-film transistors encapsulated with fluoropolymer for transparent displays

Jun-Young Jeon, Tae-Jun Ha*
Dept. of Electronic Materials Engineering, Kwangwoon University, Seoul 139-701, Korea
Tel.:82-2-940-8678, E-mail: taejunha0604@gmail.com

Transparent thin-film transistors (TTFTs) consisting of wide band-gap semiconductors have been extensively investigated to realize the unit pixels for next-generation displays requiring optical insensitivity to the visible light and electrical stability to the prolonged bias stresses [1]. Amorphous metal-oxide compounds such as indium-gallium-zinc-oxide (IGZO) and zinc-tin-oxide (ZTO) have been intensively explored for use as an active layer in transparent displays, due to higher driving current, optical transparency and on-off current ratio [2]. Significantly, reduced off-state current and enhanced electrical stability in switching TFTs can be the key to realizing high quality transparent displays where those lead to failure in designed active matrix operation [3].

In this presentation, we demonstrate an optimized process for high device performance in amorphous ZTO TFTs by employing an encapsulation method with fluoropolymer of polycrystalline poly(vinylidene fluoride-co-trifluoroethylene) (PVDF-TrFE). As shown in Fig.1., a simple and reproducible encapsulation method results in a favorable shift in the threshold voltage toward 0V and decrease in off-state current by a factor of 20. Such improved performance results from the enhanced charge transport due to the reduction in the density of trap states related to oxygen vacancies [4]. We also discuss the device physics on the electrical instability combined with photo illumination in ZTO TFTs. We believe that in-depth and comprehensive understanding on mechanism underlying charge transport can contribute to successfully drive transparent displays industry.

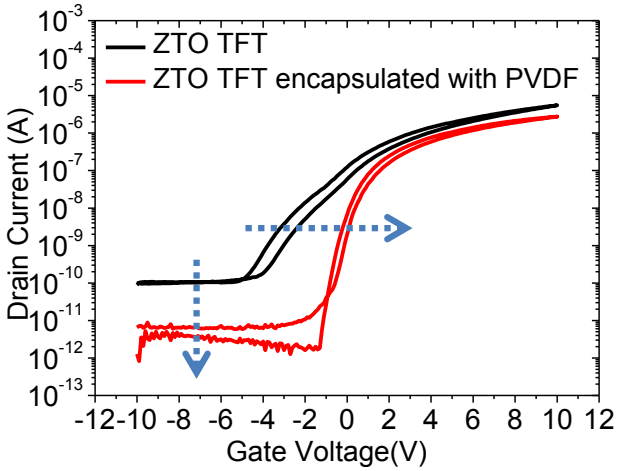

Fig. 1. transfer characteristics in ZTO TFTs with and without encapsulation with fluoropolymer of PVDF-TrFE

Acknowledgment

The work was supported by the Research Grant of Kwangwoon University and by the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT and Future Planning.(2014R1A2A1A12067505).

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