GReCoSS Process for Fabrication of Flexible Oxide TFT

JungHo Jin[1], Ji-Hoon Ko[1], Seok-Jun Seo[1], Young Hwan Hwang[1], Sang-Hee Ko Park[2], Sun Min Yoon[2], Min Ki Ryu[2], Shin Hyuk Yang[2], Oh-Sang Kwon[2], Eun-Suk Park[2], and Byeong-Soo Bae[1,§]

[1]Deptartment of Materials Sci. & Eng., KAIST, Daejoen 373-1, Korea
[2]Oxide Electronics Research Team, ETRI, Daejeon, 305-350, Korea

Tel.:+82-42-350-4119, [§]E-mail: bsbae@kaist.ac.kr

Keywords: Flexible substrate, Oxide TFT, GFRHybrimer

Abstract

*Oxide TFT arrays were fabricated on a low thermal expansion transparent plastic substrate by, so-called GReCoSS process (**G**lass-fabric **Re**inforced **C**oating Films **o**n **S**urface-treated **S**ubstrate). Using this technique, a flexible oxide TFT backplane can be released from a glass carrier plate after the TFT fabrication by a simple de-bonding without using any adhesives, laser release or transfer technique.*

1. Introduction

Recently, there are considerable interests in flexible displays due to their potential merits in terms of being able to fabricate displays that are thin, lightweight, robust, conformable and flexible. Common examples of typical flexible substrates are polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyether sulfone (PES), and polyimide (PI) etc. Recently, we reported newly developed flexible transparent glass-fabric reinforced siloxane hybrid materials (GFRHybrimer) substrate with low coefficient of thermal expansion (CTE) [1]. Although there have been extensive studies on the flexible displays built on such plastic substrates, little progress have been made in the fabrication process in terms of the methodology. In order to fabricate a flexible display, a plastic substrate must be processed on a carrier plate (usually glass) during the fabrication of TFT devices. Then, a flexible TFT backplane can be obtained by separating it from the carrier plate. To date, several fabrication methods for the implementation of flexible TFT backplanes have been introduced, including those based on using the adhesives (Samsung), the laser release method (EPLaR, Phillips), and the transfer method using laser annealing (SUFTLA, Seiko-Epson).

In this study, we report a novel fabrication process for electronic devices built on a flexible glass-fabric reinforced transparent plastic substrate, so called GReCoSS process (**G**lass-fabric **Re**inforced **C**oating Films **o**n **S**urface-treated **S**ubstrate). With this technique, a flexible TFT backplane can be released from the carrier plate by a simple de-bonding without using any adhesives, laser release or transfer technique. In the present study, we successfully fabricated a flexible oxide TFT backplane using the GReCoSS process.

2. Experimental

For the surface treatment, an epoxy-hybrimer resin (KAIST, Korea) [2] was spin-coated on a 100 x 100 mm glass carrier plate with 100~1000 nm thickness (Fig. 1a) and UV-cured. The coating was done only in the middle to leave a 10 mm margin at every edge (Fig. 1b). After the surface-treatment, a sheet of woven glass-fabric was placed on the glass plate (Fig. 1c) and coated with an UV-curable methacryl-hybrimer resin (KAIST, Korea) [3] for a complete impregnation (Fig. 1d). Then, the impregnated film was UV-cured under pressure and heat-treated at 180°C for 4 hours to form the GFRHybrimer substrate with a high transparency and a low CTE as shown in Table 1.

Indium gallium zinc oxide (IGZO) TFT arrays (bottom gate/bottom contact) were fabricated on the above substrate (Fig. 1e) [4]. The maximum process temperature was 150°C during all the TFT fabrication steps. After the fabrication of TFT, the oxide TFT backplane was released from the surface-treated glass carrier plate by a simple de-bonding without any additional process step (Fig. 1f).

Table 1. Characteristics of the Flexible Glass-fabric Reinforced Hybrimer (GFRHybrimer) Substrate [1]

Optical Transmittance at 550nm, T (%)	87
CTE (ppm/°C)	14
Modulus (GPa)	5
5% Weight Loss Temperature, $T_{5\%}$	350

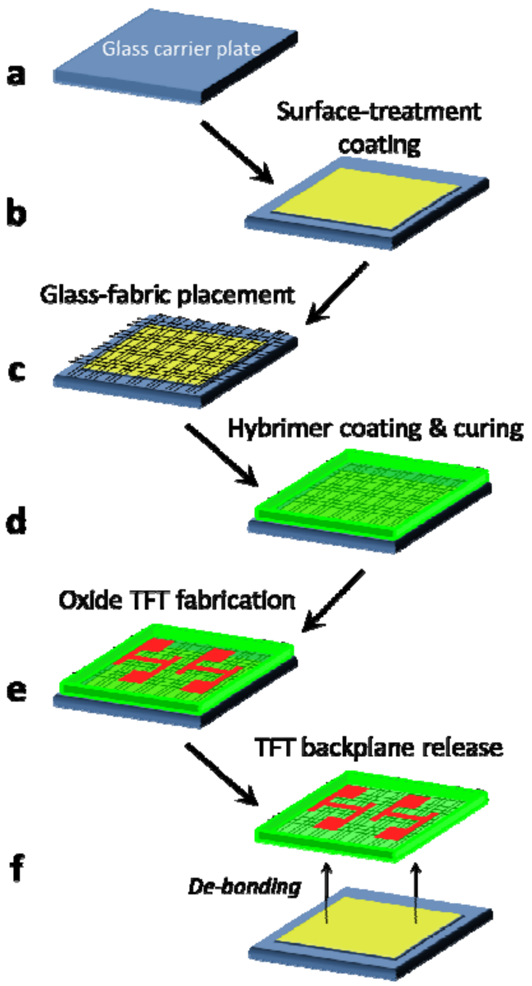

Fig. 1 Process flow of the GReCoSS process

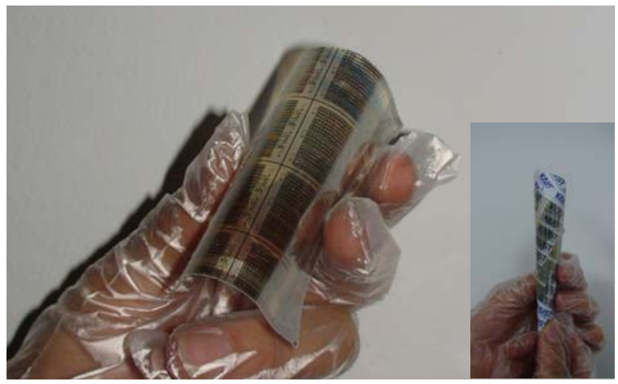

Fig. 2 Flexible Oxide (IGZO) TFT Backplane Released From a Carrier Plate Using the GReCoSS Process

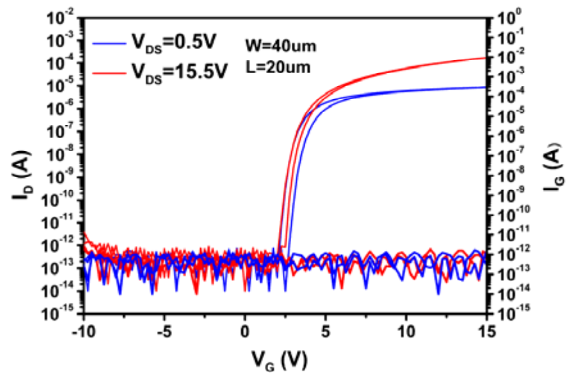

Fig. 3 Transfer characteristic of the flexible oxide (IGZO) TFT

3. Results and Discussion

The oxide TFT arrays were successfully fabricated using the GReCoSS process. Due to the low CTE of the substrate, all the TFT layers including the gate electrodes and dielectrics, the source and drain electrodes, the active channel layers (IGZO) etc. could be perfectly aligned. After the TFT fabrication, the flexible oxide TFT backplane could be released from the carrier plate with a simple de-bonding (Fig. 2). Fig. 3 shows the transfer characteristics of the oxide TFT. The electrical parameters including the saturation mobility and the threshold voltage were derived from a linear fitting to the plot of the square root of ID versus VG of the saturation region. The saturation mobility is μ_{sat} = 16 $cm^2/V{\bullet}s$ and the threshold voltage is V_{th} = 3.05 V indicating the oxide TFT is operated in accumulation mode on a positive gate bias without any degradation of the TFT performance even after the release. The TFT fabrication process will be more optimized to show better performance and bending tests of the fabricated oxide TFT will be performed.

Acknowledgement

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MEST) (No. R01-2007-000-20815-0), and by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (CAFDC-20100009898)

4. References

1. J.H. Jin, J.H. Ko, S.C. Yang, B.-S. Bae, *Adv. Mater.* Submitted (2010)
2. S.C. Yang, J.-S. Kim, J.H. Jin, S.-Y. Kwak, and B.-S. Bae, *J. Appl. Polym. Sci.*, **117**, p.2140 (2010)
3. Y.J. Eo, T.H. Lee, S. Y. Kim, J.K. Kang, Y.S. Han, B.S. Bae, *J. Appl. Polym. Sci.* B, **43[7]**, p.827 (2005)
4. M. K. Ryu, S.-H. K. Park, S. Yang, C. Byun, O.-S. Kwon, E.-S. Park, K. I. Cho, C.-S. Hwang, *SID Symposium Digest*, **43**, pp. 1367-1369 (2010)