Low-temperature activation engineering by simultaneous UV and thermal treatment in sputter processed IGZO thin-film transistors

Young Jun Tak, Sung Pyo Park, Tae Soo Jung, Heesoo Lee, Won-Gi Kim, Jeong Woo Park, Na Eun Kim, Hyun Jae Kim
School of Electrical and Electronic Engineering, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-749, Republic of Korea
Tel.:82-2-2123-5865, E-mail: hjk3@yonsei.ac.kr

Amorphous oxide semiconductor thin-film transistors (AOS TFTs) is a superior candidate for display back-plane owing to its merits such as high transparency, high mobility, and low-temperature deposition compared with the conventional amorphous Si TFTs.[1] However, an additional activation required to achieve stable semiconductor characteristics, organize chemical bonds, and alleviate defect sites is often overlooked and studies related to activation have been rarely reported. Here, we propose an activation using simultaneous UV and thermal (SUT) treatment. This treatment was conducted conjugating UV light of 185 nm and 265 nm wavelength after deposition of IGZO films is completed to decrease activation from 300^{o}C (typical activation) to 150^{o}C as well as to improve electrical characteristics and stability. As a result, we successfully decreased activation to 150^{o}C. Furthermore, SUT treated devices have superior electrical characteristics and stability than only-thermal (300^{o}C) treated devices: mobility improved from 3.23 to 15.81 cm^{2}/Vs, on-off ratio increased from 3.96 x 10^{7} to 1.03 x 10^{8}, and threshold voltage shift (for positive bias stress for 10,000 s) decreased from 11.2 to 7.2 V. These improvements are attributed to the following contributions: (1) generation of reactive oxygen radical at low temperature and (2) decomposition-rearrangement of M-O bonds such as In-O, Zn-O, and Ga-O in active layer[2]. Contribution (1) and (2) effectively increased M-O bonds and decreased defect sites related oxygen vacancies. We expect this study may be easily integrated to display industry and bring various options for flexible substrates.

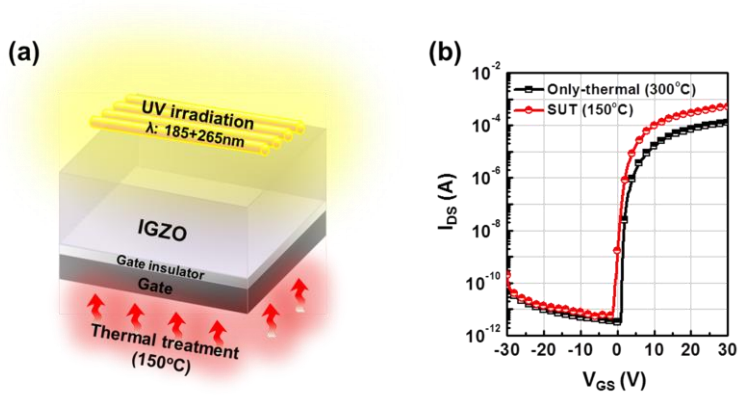

Fig. 1. (a) Schematic simultaneous UV and thermal (SUT) treatment for activation (b) comparison of transfer characteristics for only-thermal and SUT treated IGZO TFTs

Acknowledgment

This work was supported by Samsung Display and the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP) (No. 2011-0028819).

References

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2. Y. J. Tak, D. H. Yoon, S. Yoon, U. H. Choi, M. M. Sabri, B. D. Ahn, H. J. Kim, *ACS Appl. Mater. Interfaces*, vol. 6, 6399-6405 (2014).