.Image recognition process of IGZO/$CsPbBr_3$ photo-synaptic transistors imitating human learning processes

Go Eun Choi, You Seung Rim

Department of Intelligent Mechatronics Engineering, and Convergence Engineering for Intelligent Drone, Sejong University, Seoul 05006, Republic of Korea

*Corresponding email: youseung@sejong.ac.kr

Neuromorphic devices are consisted of mimic structures of neurons and synapses in the human brain, which can simultaneously process computation and memory roles for the high-speed computations and high-power efficiencies. Recently, light-applied optical synapses with light applied among neuromorphic semiconductors systems have received attentions due to low crosstalk, wide bandwidth, fast computation, and lower energy consumption [1].
In this study, perovskite $CsPbBr_3$ photo absorber embedded IGZO semiconductor-based photo-synaptic transistors were proposed. Oxide semiconductor (IGZO) is being actively studied because it can realize high mobility and high transparency with low process temperature and low manufacturing cost [2]. However, since the bandgap is wide, there is a limitation in not recognizing light in the visible ray region. $CsPbBr_3$ has a low bandgap (~2.3 eV) and can be formed easily onto the IGZO surface using a solution process. In the optical synaptic arrangement, as the number of pulses increased and the intensity of light increased, the image tended to be clearly recognized [3]. It is consistent with the fact that the more often humans meet, the more facial features they remember [4]. We prove that the image recognition process of the produced photo-synaptic array is similar to that of human learning.

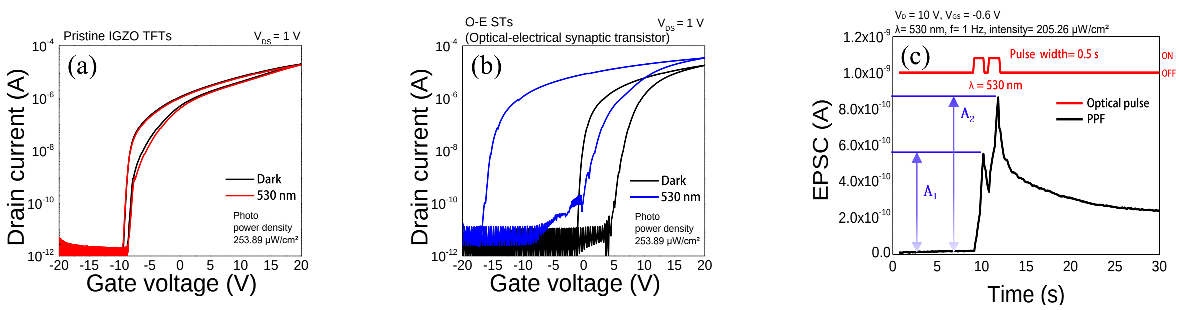

Figure 1. Transfer characteristics of the (a) Pristine IGZO transistors and (b) Optical-electrical synaptic transistors (V_{DS}= 1 V) in the dark and under the illumination of 530 nm wavelength. (c) persistent photoconductivity (PPC).

Acknowledgments

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT)

(No. 2020R1A2C1013693), Korea Institute for Advancement of Technology (KIAT) grant funded by the Ministry of Trade,Industry & Energy (MOTIE, Korea) (P0012451, The Competency Development Program for Industry Specialist) and the Technology Innovation Program - (20016102, Development of 1.2kV Gallium oxide power semiconductor devices technology, RS-2022-00144027, Development of 1.2kV-class low-loss gallium oxide transistor) funded by MOTIE.

References

[1] Zhu, QB., Li, B., Yang, DD. et al. Nat Commun **12**, 1798 (2021).

[2] Jiazhen Sheng, TaeHyun Hong, Hyun-Mo Lee, KyoungRok Kim, Masato Sasase, Junghwan Kim, Hideo Hosono, and Jin-Seong Park, ACS Applied Materials & Interfaces **11**, 43 (2019).

[3] Maina Moses Mburu, Kuan-Ting Lu, Nathaniel L. Prine, Ai-Nhan Au-Duong, Wei-Hung Chiang, Xiaodan Gu, Yu-Cheng Chiu **7**, 8 (2022).

[4] Chanho Jo, Jaehyun Kim, Jee Young Kwak, Sung Min Kwon, Joon Bee Park, Jeehoon Kim, Gyeong-Su Park, Myung-Gil Kim, Yong-Hoon Kim, Sung Kyu Park, Advanced Materials **34**, 12 (2022).

Keyword photo synaptic arrays, Perovskite quantum dots, Oxide semiconductor, Thin film transistor.