TRI-LAYER SELF-ALIGNED STRUCTURE INDIUM GALLIUM ZINC OXIDE THIN FILM TRANSISTORS WITH OPTICAL SYNAPTIC PLASTICITY

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Since the 1950s, computer computing has been governed by the von Neumann architecture, which allows data to be transmitted across the processor and memory for computation. Nowadays, the demand for large amounts of information transmission has limited the processing speed by the memory bandwidth and generated higher power consumption. The Human brain can perform high-speed operation, store and calculate as one, so the human neuromorphic computation is the next-generation architecture to solve the “von Neumann bottleneck” [1-2]. In this work, we have successfully developed tri-layer self-aligned structure indium gallium oxide (IGZO) thin-film transistors (TFTs) with optical-synaptic plasticity. The channel conductance of IGZO TFTs would be modulated after the pulse voltage input from gate electrode. The conductivity of the IGZO channel decreases when the pulse voltage is positive, and conversely, the conductivity of the IGZO channel increases when the pulse voltage is negative. In addition, exposure of the devices to blue light can enhance the magnitude of the conductivity spike under negative bias pulses because of the electron hole pairs generated after the illumination. The tri-layer self-aligned structure can further reduce the defects in the back channel of the transistor, which can more effectively increase the channel conductivity after illumination and is more suitable for synaptic devices application.

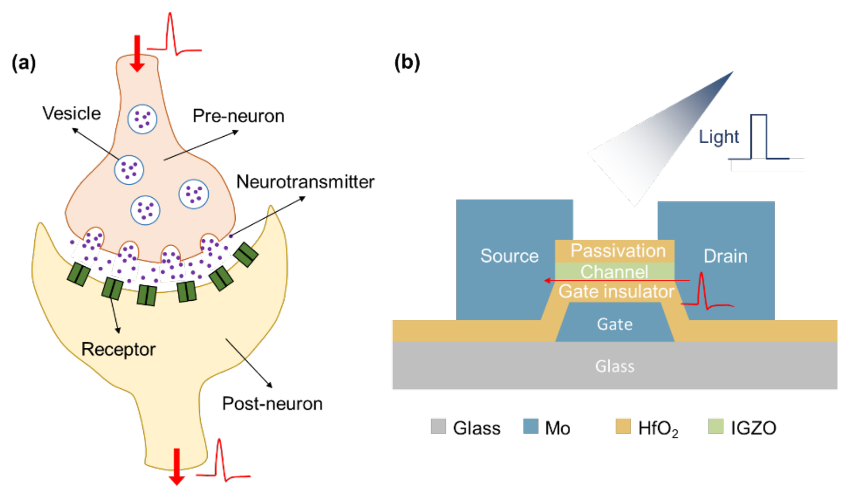

Figure 6 – (a) Schematic diagram of the architecture of a single synaptic neuron for transmission in the human neural system. (b) Schematic diagram of the structure of an indium gallium oxide thin-film transistor sensor with tri-layer self-aligned structure, which utilizes photosensitive properties for application in artificial neural-like computing systems.

[1] R. Yang *et al.*, "Optoelectronic Artificial Synaptic Device Based on Amorphous InAlZnO Films for Learning Simulations," *ACS Applied Materials & Interfaces,* vol. 14, no. 41, pp. 46866-46875, 2022.
[2] L. Hu *et al.*, "All-optically controlled memristor for optoelectronic neuromorphic computing," *Advanced Functional Materials*, vol. 31, no. 4, p. 2005582, 2021.