Flexible and Stretchable Organic Artificial Nerves

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Biological nervous systems are powerful for solving complex real-world problems such as visual information processing, speech recognition, and movement control due to their compactness, fault tolerance, and high-power efficiency [1]. For information processing, classical von Neumann–based computing systems depend on centralized and sequential operations with a clock cycle, while biological nervous systems are based on distributed, parallel, and event-driven operations. In this regard, as a solution for efficient processing of large quantities of complex data, the concept of the neuromorphic electronics which emulate the functions and the information processing of biological nervous systems have appeared. Thus, neuromorphic electronics which emulate the biological nervous systems at the hardware level have attracted much attention. Emulation of the complicated biological sensory and motor nervous systems related to proprioception, signal processing, and motor response is a challenging issue especially to realize humanoid robotics and neuroprosthetics.

Here, we demonstrated organic artificial synapses and nerves for sensory and sensorimotor nervous systems [2,3]. The artificial sensory organs detect stimuli and fire artificial action potentials which will be transmitted to organic synapses. Then, the organic synapses generate a post-synaptic signals which will stimulate motor neurons and muscles. We demonstrated i) a hybrid reflex arc system composed of artificial tactile-sensory nerves and biological motor nerves in a detached insect leg, and ii) optoelectronic sensorimotor nervous system composed of an artificial photoreceptor and electronic neuromuscular system with an artificial muscle fiber. In addition, we showed that these neuromorphic systems are promising to develop human/machine interface by distinguishing braille characters and conducting wireless optical communication. Our organic artificial synapses for sensory and motor nervous systems can be used for human-like soft robots and prosthetics which help people with neurological disabilities.

REFERENCES

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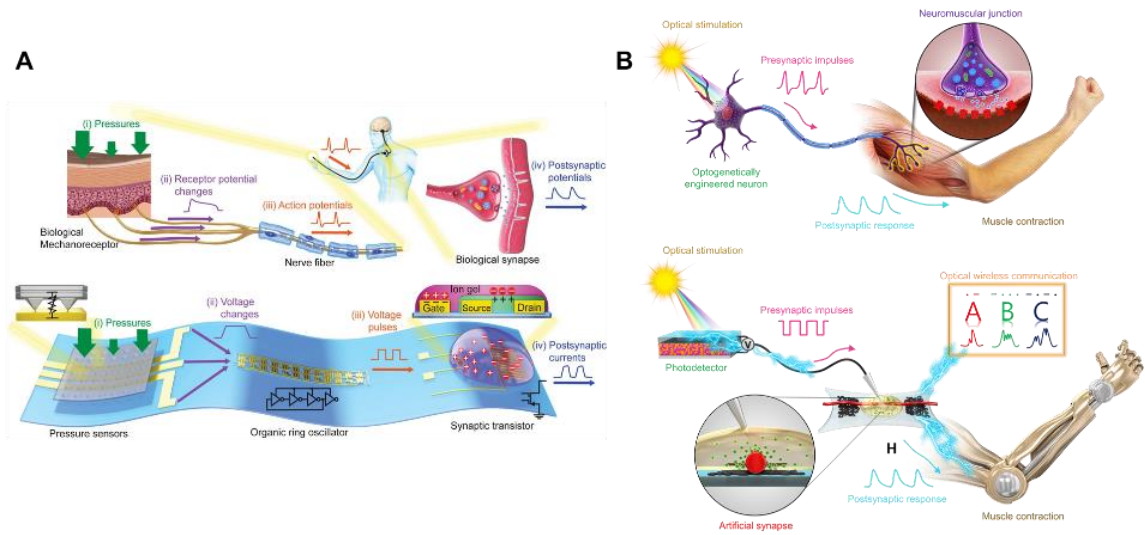
Figure 1: Schematics of (A) biological and artificial tactile sensory nervous systems and (B) artificial sensorimotor nervous systems.