Electron ics

Self-Powered AI Optoelectronic Sensors

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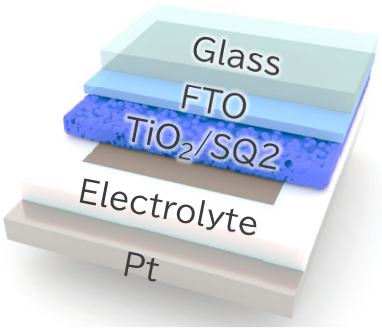
Purpose of Research

With the growing demand for low-power and high-speed processing of time-series data in edge devices, we are developing light-responsive synaptic devices with short-term memory and nonlinear characteristics. This research aims to apply such devices as the physical reservoir layer in physical reservoir computing (PRC). In particular, we focus on a next-generation AI sensor that operates without an external power source, utilizing a self-powered optoelectronic synapse based on dye-sensitized solar cells (DSCs).6

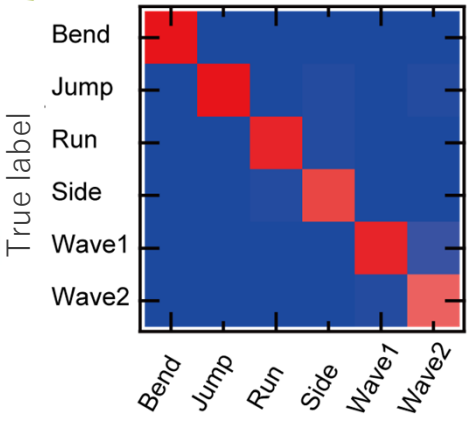
Summary of Research

We have developed an artificial synapse device that requires no external power supply by leveraging the photovoltaic and charge-retention properties of DSCs. The device exhibits transient voltage responses with variable time constants depending on light intensity and wavelength. These responses enable short-term memory and nonlinear behavior, which are key properties for reservoir computing. The device functions as a core element of a PRC system, facilitating the real-time processing of dynamically changing optical signals. This makes it highly promising as a low-power intelligent sensor.

Classify human motions without a camera!



Device structure



Comparison with Conventional or Competitive Technologies

・Conventional artificial synapses require external power and consume significant energy. This device operates without a power supply

Expected Applications

・Wearable environmental sensing
・Optical edge sensing modules
・Smart agriculture
・Remote health and motion monitoring

Challenges in Implementation

・Improving durability under outdoor conditions
・Enhancing uniformity and reproducibility
・Integration for practical implementation

Points

・Self-powered optoelectronic synaptic device
・No external power required
・Optimized for real-time processing of time-series signals via PRC framework

What We Expect from Companies

・Joint development with companies in sensing applications (wearable, agriculture, construction, mobility, etc.)
・Co-development of next-generation power-saving AI devices for global markets

Future Developments

2026.4 Start of prototype array development
2027.3 Field testing in environmental and agricultural monitoring
2028.4 Joint development with companies and launch of commercial applications

■Award : SEMICON Japan 2024 Academia Award
■ Prototype: Available

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