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Organic Nervetronics for Neuroprosthetics

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Nerve injuries can lead to paralysis, significantly reducing their quality of life and, in severe cases, becoming life-threatening. To address this issue, neuroprosthetics are being developed. However, current neuroprosthetic systems rely on conventional von Neumann architecture, which struggles to replicate the complex behavior of biological nervous systems. In contrast, "nervetronics"—based on ion-gel-gated synaptic transistors—more effectively mimic the functional properties of biological nerves. Crucially, incorporating the short-term plasticity-dominated synaptic properties of nervetronics into neuroprosthetics could lead to significant advancements.

In this study, we demonstrate stretchable neuromorphic efferent nerves that can interface with the muscles of living animals via PEDOT:PSS hydrogel electrodes. Our nervetronic system successfully replicated natural movements in the hind limbs of mice, including bipedal motion and practical tasks such as kicking a ball and walking or running. Additionally, electrophysiological signals recorded from the system were able to induce muscle movement through the nervetronic interface. This work provides fundamental insights and a proof-of-concept for the application of nervetronics in future neuroprosthetic development.