Time-Delayed Reservoir Computation with Ag-Ag_2S Core-Shell Network Device

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Reservoir computing (RC), an input signal is projected onto a high-dimensional space, is an attractive computing framework. The structure of conventional neural networks results in a large power consumption because of all the multilayer signals calculation. Compared to conventional neural networks, RC can significantly reduce the learning complexity as only readout layer is trained. It has been realized that hardware-based RC can perform computations at high speeds and with low power consumption. Instead of using echo state network [1] (ESN), time-delay reservoir computing uses time-delay with a single reservoir node. Using amplification and delay, input values enter the reservoir node, and output values enter the neuron once more. Here we investigated, time-delay reservoir computing performance usingAg-Ag2S nanoparticles atomic switch device.

Ag-Ag_2S nanoparticles were fabricated using the modified Brust-Schiffrin[2] method, which gives them a core-shell structure. Platinum (Pt) electrodes with a 40 nm thickness were deposited on a SiO_2/Si substrate. The nanoparticles then fell onto the junction between the two electrodes.

The Ag-Ag_2S nanoparticle device showed a nonlinear current-voltage behavior. Using this nonlinearity, we carried out benchmark tasks such as waveform generation by applying time-delayed RC as shown in Fig.1. In the circuit used for the waveform generation task, an instrumental amplifier is used as the amplifier. A LabVIEW circuit was used to implement the delay process, and MULTIDAQ was used to record each signal that came out of the device. As shown Fig 2.

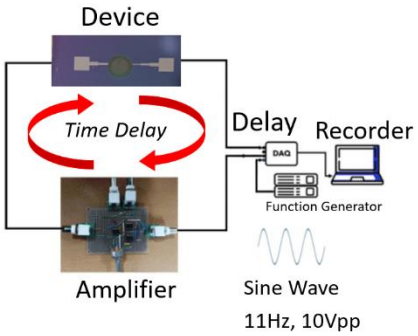

Fig.1 Waveform generation task with Time-Delay Circuit waveforms

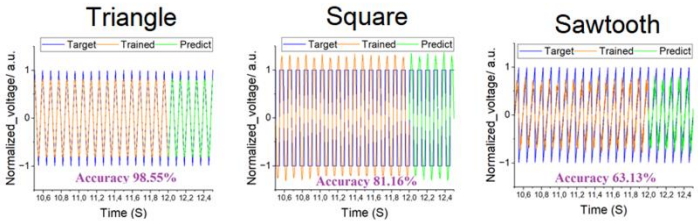

Fig.2 Waveform generation task results in (a) Triangle, (b) Square, (c) Sawtooth waveforms

Ref [1] Wlaźlak, E, et. al., App. Electro. Mat., ***2***, 329-338 (2020).
[2] C. Battocchio, et al., J. Phys. Chem., ***116***, 19571-19578 (2012).