Short-term and long-term memory of random aggregation device using Ag-Ag$_2$S nanoparticles

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[Introduction] Neuromorphic devices are expected to have a high-performance arithmetic circuit with very low power consumption to be applied in many fields, such as brain-like computer. Especially it is important to control the structure of random network for reservoir computing application. In the present study, we demonstrated a cross-talk, learning behavior among the Ag-Ag$_2$S core-shell nanoparticles aggregation and neuromorphic behavior.

[Experimental] The Ag-Ag$_2$S core-shell nanoparticles were synthesized by modified Brust-Schiffrin procedure [1] at room temperature with Ag/S molar ratios of 0.25/1 as follows: A toluene solution of allylmercaptane (0.37 ml, 4.71 mmol) is mixed with a solution of silver nitrate (200 mg, 1.18 mmol). Then, tetraoctylammonium bromide in deionized (DI) water (360 mg, 0.658 mmol) was added to the solution and followed by adding sodium borohydride solution in DI water (260 mg, 6.87 mmol). The mixture was allowed to react for 2 h at room temperature with magnetic stirring. The water phase was then removed from obtained solution and then was centrifuged at 4000 rpm for 20 min to separate the nanoparticles from the liquid phase.

Figure 1 XRD of Ag-Ag$_2$S core-shell nanoparticles. Inset: XPS and TEM of nanoparticles

[Results and discussion] The structural properties of Ag-Ag$_2$S nanoparticles were investigated by XRD, XPS and TEM as shown in **Figure 1**. It clearly showed that the particles have the range 20-100 nm of diameter and consisted of two different crystal structures, namely Ag as the core and Ag$_2$S as the shell. To create aggregation of particles, the highly concentrated nanoparticles in ethanol were drop-casted on to 50 ℃ of 4-electrodes device and characterized the learning properties by repeated sweeping the bias as shown in **Figure 2**. Furthermore, the memorization process, such a short-term and long-term memorization was studied by applying rectangular wave input. The details will be presented at the conference.
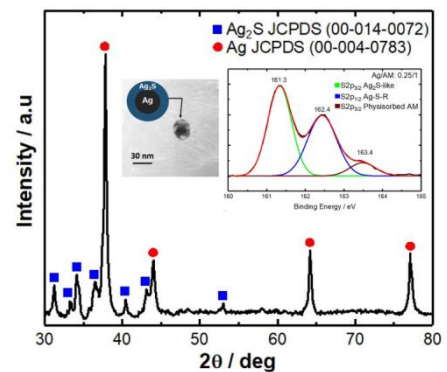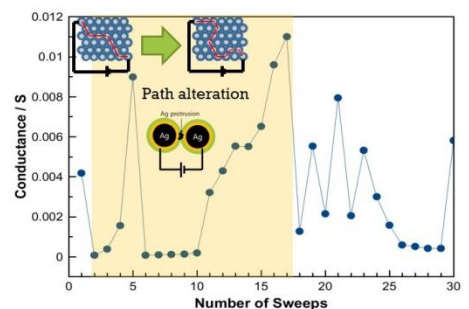

Figure 2 Conductance of random aggregation using Ag-Ag$_2$S core-shell nanoparticles at 5V after several times of sweeps.

Keywords: *Memristive behavior, Short-term memory, Long-term memory, Ag-Ag$_2$S core-shell nanoparticles*

Reference:
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