

Memristive behavior of random aggregation device using Ag-Ag₂S core-shell nanoparticles

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Compared to Von Neumann computer, neuromorphic devices are expected to have a high-performance arithmetic circuit with very low power consumption to be applied in many fields, such as reservoir computing. In the present study, we demonstrated a resistance variation memory among the Ag-Ag₂S core-shell nanoparticles aggregation and its neuromorphic behavior. The Ag-Ag₂S core-shell nanoparticles were synthesized by modified Brust-Schiffrin procedure at room temperature with Ag/S molar ratios of 0.25/1; 0.5/1; and 1/1. The fabrication of Ag-Ag₂S core-shell nanoparticles with Ag/S molar ratios of 0.25/1 is 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. The structural properties of Ag-Ag₂S 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 Ag₂S as the shell. To create aggregation of particles, the highly concentrated nanoparticles in ethanol were drop-casted on to 50 °C of 4-electrodes device and characterized the learning properties by sweeping the bias as shown in **Figure 2**. Furthermore, the memristive behaviour of all connections made by 4-electrodes to control the functionality of the device was also studied. The details will be presented at the conference.

Keywords: Atomic switches, Reservoir Computing, Ag-Ag₂S core-shell nanoparticles

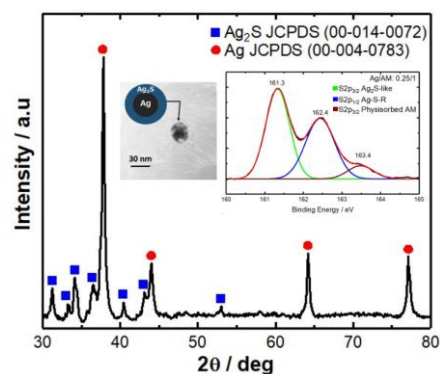


Figure 1 XRD of Ag-Ag₂S core-shell nanoparticles. Inset: XPS and TEM of nanoparticles

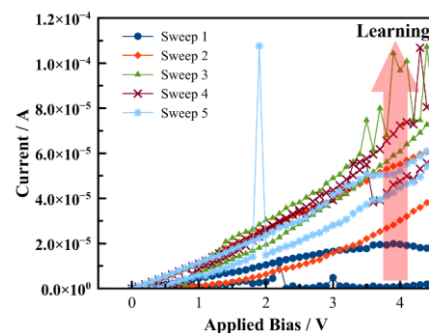


Figure 2 Memristive behavior of random aggregation using Ag-Ag₂S core-shell nanoparticles