Random network fabrication using Ag-Ag$_2$S core-shell nanoparticles for reservoir computing

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Brain-like devices have a high-performance arithmetic circuit with very low power consumption. The system mimicking human brain information processing is expected to be applied in many fields. In the present study, we demonstrated a fabrication of the network among the Ag-Ag$_2$S core-shell nanoparticles and its electrical properties for reservoir computing application. To fabricate the random network, Ag-Ag$_2$S nanoparticles were synthesized by sulfidation of Ag nanoparticles in aqueous solution as following: 2.08 g of silver acetate in 20 mL toluene and 10 g of dodecylamine (DDA) was used as starting materials. Then, 2.08 g of phenylhydrazine in 20 mL toluene was added dropwise to the silver acetate solution with stirring in oil bath at 60°C and at 300 rpm for 1 h. The black color solution was obtained during dropwise process, indicating the formation of DDA-capped Ag nanoparticles. The Ag/DDA was then filtered and then the sulfurizing process was performed in wet chemical reaction by utilizing Na$_2$S·9H$_2$O aqueous solution as the source of sulfur ions. The solution was then filtered and diluted hydrogen peroxide was added to suppress the reactivity of Na$_2$S·9H$_2$O. The solution was then centrifugated at 2600 G for 30 min to separate the nanoparticles. The structural properties of Ag-Ag$_2$S nanoparticles were investigated by XRD as shown in Figure (1). Then, the nanoparticles were drop-casted on 8-electrodes device to create random network using dielectrophoresis as shown in Figure (2). The electrical properties of such device were then measured. The device showed increase of electrical current after applying bias indicating the formation of metal bridge between particles, as shown in Figure (3). The forward and reverse bias applied to the device also studied and showed memristive behavior. The detail will be shown in the conference.

Keywords: Atomic switches, Reservoir Computing, Ag-Ag$_2$S core-shell nanoparticles