Modulation of the resistance switching behavior of Ag_2S-based switches using graphene oxide layer

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Introduction: Ag_2S-based switches have attracted attention due to its neuromorphic switching operation, in which voltage inputs cause the formation and annihilation of conducting Ag filaments.[1] Since the switching behavior mainly depends on Ag_2S bulk material, enhancing controllable parameters is essential. In this work, a modification to Ag_2S-based switches is proposed by the addition of graphene oxide (GO) thin films.

Experimental: Ag_2S was fabricated via sulfurization of silver in a 0.1% Na_2S solution. GO was deposited via a facile dip coating procedure, and the structural properties of the surfaces were evaluated by the Raman spectra and a scanning electron microscope. The switching properties in the connections between the Pt and Ag/Ag_2S or Ag/Ag_2S/GO wires were carried out using a semiconductor characterization system.

Results and Discussion: The Raman spectra observed from the Ag_2S and Ag_2S/GO surfaces are shown in Fig. 1 (a). The observation of the characteristic G-band indicates the presence of GO. Since the intensity of the G-band peak reflects the amount of GO, the graph indicates that the film thickness of GO layer can be controlled by the coating times. The I-V results of the fabricated samples are shown in Fig. 1(b). The clear hysteretic behavior of the connection between the Pt and Ag/Ag_2S/GO wires reveals the compatibility between GO-thin films and the filamentary switching of Ag_2S. In addition, GO-modulated samples exhibited lower OFF state currents (from 10^{-7}A in Ag/Ag_2S to 10^{-8}A in Ag/Ag_2S/GO) due to the insulating nature of GO. As shown in Fig. 1(c), the time evolution analysis of the conducting states revealed that the volatility of the filaments increases by introducing GO layers when the same input was applied to the system. Thus, we conclude that the additional GO layers have a modulation effect on the neuromorphic properties on Ag_2S-based switches.

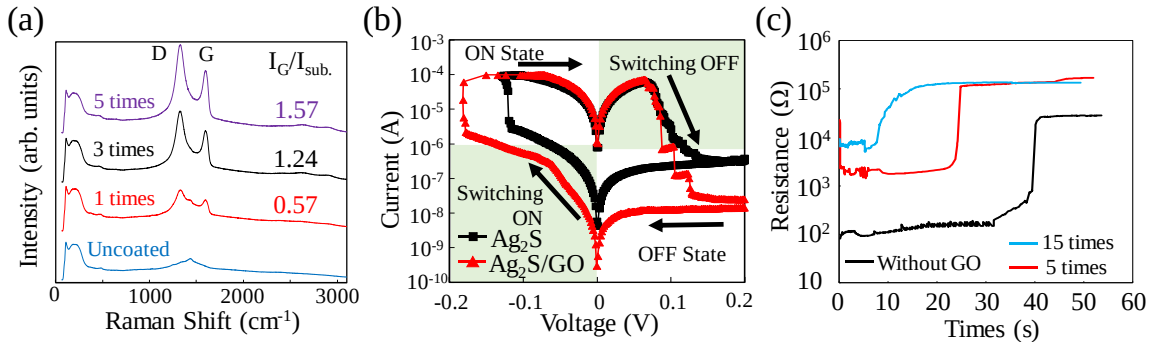

Fig. 1(a) Raman spectra of the surface of Ag_2S and Ag_2S/GO at different dip coating conditions, (b) I-V curves obtained using the sweeping voltage mode of the characterization system and (c) volatility observed by monitoring the time evolution of the conducting states.

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1) T. Ohno, et al., Nat. Mater. **10**, (2011) 591.