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Resistive Switching in a Printed Nanolayer of Poly(4-vinylphenol)

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Resistive switching in organic resistive switches fabricated with a sandwich structure of indium tin oxide (ITO)-coated polyethylene terephthalate (PET)/poly(4-vinylphenol) (PVP)/silver (Ag) is reported. A single layer of PVP was used as an active layer in the sandwich structure between the two electrodes. The active layer of the polymer was atomized with the electrohydrodynamic atomization technique on the ITO-coated PET. The film thickness of the PVP polymeric layer on the ITO-coated PET was measured to be 110 nm. The surface morphology was characterized by field-emission scanning electron microscopy, and the purity of the film was examined by x-ray photoelectron spectroscopy analysis. Electrical current–voltage (*I*–*V*) measurements confirmed the memristive behavior of the sandwich device. The effect of the current compliance (CC) on resistive switching in the fabricated sandwich structure was also explored. The PVP-based organic resistive switch showed a CC-dependent OFF/ON ratio and memory window. Resistive switching memory effects were prominent at low CC up to nanoamps. The as-fabricated device was operated with low operational voltages for both polarities with OFF/ON ratio greater than 100:1. The robustness of the fabricated memristor was checked with multiple voltage sweeps, and the retention time is reported to be over 100 min.

Key words: Bipolar switching, electrohydrodynamic atomization, electroforming process, organic memristor, resistive switch

INTRODUCTION

Resistive switches (memristors) are the hope not only for the next generation of memory technology, but also for switching elements in electronics applications. Organic resistive switches have the advantages of simple device structure, low fabrication cost, and printability compared with their inorganic counterparts.[1–5] Structurally, organic memories or resistive switches can be categorized into four classes: (1) single-layer structure without nanoparticles (NPs), (2) bilayer structure containing two kinds of polymers, (3) structure with nanotraps buried in the middle of an organic layer, and (4) polymer–NP composite with NP traps randomly distributed throughout the entire host polymer.[2] Polymeric electronic memories have been reviewed in literature, emphasizing the organic material, device structure, and the resistive switching phenomenon involved in polymers.[1,2]

Poly(4-vinylphenol) (PVP) is one of the most common polymers being used in dielectric applications for thin-film transistors (TFTs), cross-linking agent applications, and write-once read-many (WORM) memories, and also has been employed in resistive switching memory applications. PVP has shown memory effects after mixing with molecules as the charge-storage medium for resistive random-access memory applications.[3] PVP was employed in an 8×8 WORM memory cross-bar array.[6] High OFF/ON ratio with long retention time was reported for the composite structure of PVP. Thin films of PVP between Al and Au electrodes have been fabricated for WORM memory applications.[7]

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