Highly uniform and reliable polymer memory via iCVD using multilayer graphene barrier electrode

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Abstract

Recently, there has been strong demand for flexible nonvolatile memory for large area, low cost, and low power flexible electronics. As a promising next-generation flexible nonvolatile memory, we present a poly(1,3,5-trimethyl-1,3,5-trivinyl cyclotrisiloxane) (pV3D3)–based resistive switching memory (RRAM) that can be easily fabricated using the initiated chemical vapor deposition (iCVD), which provides a solvent-free, low-temperature, and damage-free deposition of highly uniform polymer films on various substrates including flexible substrate. The Cu/pV3D3/Al RRAM device has reliable memory performance in terms of retention, but high reset power consumption, nonuniform resistive switching uniformity, poor endurance issues remain to be addressed. To realize lower power and reliable pV3D3-based RRAM, we introduced a multilayer graphene (MLG) film as Cu diffusion barrier, which suppresses the diffusion of Cu ions through pV3D3 films, resulting in the ultralow reset current due to the high out-of-plane resistance of MLG. In addition, the high thermal conductivity of graphene suppresses the reset process by thermal effect and a high interfacial resistance at the pV3D3/MLG interface induces Cu filament formation/rupture at the interface by electrochemical redox reaction, improving the nonuniform resistive switching uniformity and poor endurance. These dramatic improvements of pV3D3-based RRAM by inserting MLG as interfacial layer are promising not only for filament type RRAM devices which are suffer from the nonuniform resistive switching but also for polymer-based RRAM devices which are suffer from thermal instability, thus paving the way of a new area of application for graphene in the nonvolatile memory devices.