Interface engineering by inserting multilayer graphene barrier electrode for low power and highly uniform polymer nonvolatile memory

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Abstract

Recently, as one of the most promising next-generation flexible nonvolatile memory, resistive random access memory (RRAM) has attracted much attention due to its outstanding characteristics. Among various materials for resistive switching, polymer thin films are of significant interest due to its low cost, easy process, and flexibility, but uniformity and reliability issues remain to be addressed. To realize a highly uniform and reliable polymer RRAM, 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 and nonuniform resistive switching uniformity issues remain to be addressed. To address these problems, we introduced a multilayer graphene (MLG) films into interface of the electrode-polymer in pV3D3-RRAM. The ultralow power consumption is due to the role of Cu diffusion barrier, which suppresses the diffusion of Cu ions through pV3D3 films, resulting in the ultralow reset current by the high out-of-plane resistance of MLG. In addition, the improved switching uniformity is attributed to the effective heat sink by the high thermal conductivity of graphene and the local electric field enhancement at the pV3D3-MLG interface. In addition, the inserted MLG films enabled alternation of resistive switching operation mode form unipolar switching to bipolar switching and caused self-compliance behavior. The innovative strategy using graphene interfacial layer can pave the way of a new application of graphene toward low power consumption and highly uniform polymer nonvolatile memory.