Effects of ambient and photo-illumination on electrical characteristics in the γ-Fe_2O_3 nanoparticle assembly-based memristors

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Currently, memristive devices have been considered as promising candidates for next generation nonvolatile memories because of small size, low cost, 3-dimensional stackable structure, and simple process [1]. Particularly, nanoparticles-activated memristors are easy to be described by time-varying resistance and have been studied for realization of the energy-efficient neuromorphic system [2]. Furthermore, the memristors controlled by photo-illumination are potentially attractive for a new functionality of energy-efficient neuromorphic systems [3, 4]. However, the effect of photo-illumination has rarely been investigated in the nanoparticles assembly (NPA)-based memristive devices. In this work, the effects of ambient and photo-illumination on electrical characteristics in the γ-Fe_2O_3 NPA memristors [Fig. 1(a)] are experimentally analyzed.

The current under air (vacuum) ambient is gradually (rarely) modulated during a dc SET/RESET process [Fig. 1(b) and (c)], which suggests the oxygen-related redox process plays a critical role of a stable operation of the γ-Fe_2O_3 NPA memristors and accelerates mainly RESET operation. In contrast, the photo-illumination reinforces a SET process [Fig. 1(d)] and the illumination-increased current maintains for a quite long time even after the illumination is removed. Related physical mechanisms will be discussed in detail with the extraction of carrier life time. Our result is potentially useful for exploring new functionalities of the light-controlled and/or redox-based NPA memristive device and circuit.

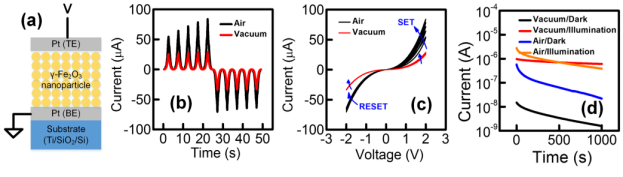

Fig. 1. (a) Schematic of the γ-Fe_2O_3 NPA memristor. Ambient-dependences of SET/RESET current measured by (b) a pulsed and (c) cyclic I-V sweep. (d) The ambient/photo-illumination dependence of transient current.

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