Disk shaped growth of silver electrodeposit in Ge-(Sb)-Te films

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ABSTRACT

Growth of electrodeposit or conductive filament is the basis of resistance switching in an Electrochemical Metallization (ECM) memory cell, or also called as a Conductive Bridge Random Access Memory (CBRAM), which is a prime candidate for future memory devices because of its low power consumption, and high scalability. One of the essential parameters which determine the memory characteristics is the shape of the electrodeposit or filament, which has been regarded as dendritic lines or truncated cones. In this paper, we present evolution of disk shaped electrodeposit in *electrode-free* Ge-(Sb)-Te films.

Electrode-free Ge-(Sb)-Te films were simply formed by RF magnetron sputtering; a 50 nm thick GeTe or $Ge_2Sb_2Te_5$ (GST) film was formed on a 50nm thick Ag film. The Ag film diffused into the chalcogenide film to form Ag-GeTe or Ag-GST. Tungsten probes with tip radius of ~ 12 μm were used to directly contact the Ag diffused chalcogenide films. Voltage was applied between the probes. The electrodeposit growth was directly monitored by in-situ optical microscopy under the saw-tooth bias cycle as shown in Fig. 1(a) and (d). Figure 1(b) and (c) show the surface of Ag-GeTe, which demonstrates growth of disk-shaped region from the negative biased probe. The growth was saturated after several bias cycles. Similar disk-shaped electrodeposit was found also in Ag-GST [Fig. 1(e) and (f)]. In the case of the Ag-GST, the disk-shaped area grew more steadily; even after 15th bias cycle, it grew like that of annual ring. We discuss the efficient growth of electrodeposit found in GeTe and GST and the resistance switching during it.

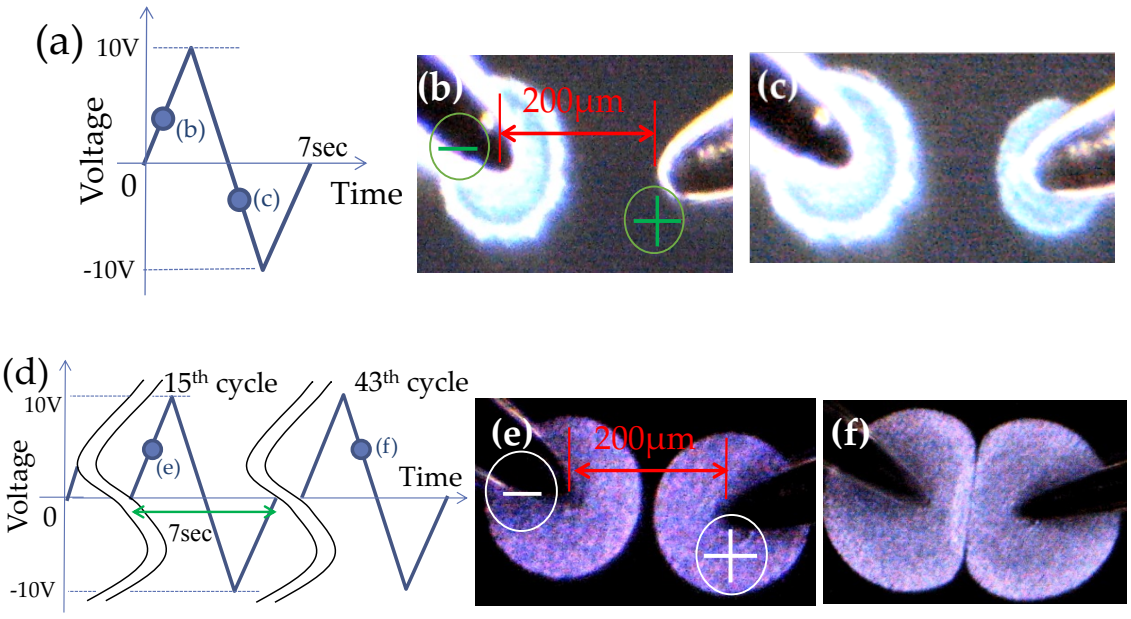

Fig.1(a) Voltage cycle and (b,c) optical micrographs of GeTe on Ag without electrodes at the voltages shown in (a). (d)Voltage cycles and (e,f) optical micrographs of GST on Ag without electrodes at the voltages shown in (d).

Key words: GeTe, GeSbTe, electrodeposit, electrochemical metallization memory, filament growth