A study on phase transition behaviors of $GeCu_2Te_3$ phase change material for PCRAM application

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ABSTRACT

Our group has studied the effect of doping element, X on the crystallization temperature in GeTe-based phase change material (PCM) and found that Al, Si and Cu are very effective to improve the thermal stability of Ge-Te amorphous film, based on the total bonding enthalpy of amorphous Ge-Te-X. Among them, Ge-Cu-Te ternary film has been found to have various advantages for PCRAM application. According to Ge-Cu-Te phase diagram, there is a $GeCu_2Te_3$ (GCT) compound with a melting point of about 500°C. Moreover, Cu_2Te-$Ge_{33.3}Te_{66.7}$ pseudobinary phase diagram indicates that the liquidus line deeply decreases toward the GCT compound composition like eutectic-type phase diagram, which suggests that the amorphous phase can be easily obtained around the compound composition. GCT amorphous was found to exhibit a crystallization temperature of about 230°C. It was confirmed that GCT memory cell shows a reversible phase transition between amorphous and crystalline states and has a lower power consumption for reset operation than GST memory cell. In addition, it was found by static laser testing that the phase change speed of GCT film is as fast as that of $Ge_2Sb_2Te_5$ film. Furthermore, GCT showed unique phase transition characteristics, namely, a small volume expansion and reflectance decrease by crystallization. Such changes upon phase transition for the GCT are opposite to those for conventional PCMs. AIMD simulation suggests that such unique phase transition characteristics would be due to unusual structural features of GCT amorphous, such as short Cu bond lengths, threefold rings, and dense Cu-rich regions. In this presentation, recent progress of study on phase transition mechanism of GCT phase change material and the memory device characteristics will be discussed.

Key words: GeCuTe, phase , etc.