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# $Bi_2Te_3$ doped $Ge_2Sb_2Te_5$ Thin Films for the Phase Change Random Access Memory Application

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The Bi doped $Ge_2Sb_2Te_5$ (GST-Bi) films were prepared and their phase transition characteristics were studied for the phase change random access memory (PRAM) application. Amorphous Bi-doped GST phase changing thin films with the different Bi concentrations were deposited by the co-sputtering technique. The GST-Bi films exhibited two kinds of phase transition; from amorphous to cubic and from cubic to hexagonal transitions with the increasing annealing temperature as the GST films do. The resistivity of the as-grown amorphous GST-Bi films decreased from $10^4$ Ω·cm for the pure GST to $10^2$ Ω·cm when the Bi concentration was 8.7 %. When the amorphous GST-Bi films were transformed into cubic phase by the thermal annealing at about 150 ℃, the resistivity of the film was reduced by more than 3 orders of magnitude. The cubic to hexagonal transition, which occurred in the temperature range from 275 ℃ to 300 ℃, resulted in the second drop in resistivity of about 10 times. The GST-Bi films showed lower RESET voltage without an increase of SET resistance and faster SET speed than GST films. In particular, the GST-Bi with 4.2 % Bi exhibited 40 % decrease in the RESET voltage and 50 % increase in the SET speed. The resistance ratio was sufficiently large (> 100) which was maintained after at least 1000 switching cycles. The lower boding enthalpy of Bi-Te than those of Ge-Te and Sb-Te and more relaxed structures of GST-Bi were believed to result in the lowering of the activation energy barrier for the amorphization and crystallization. This might result in the lowering of RESET voltage and increased the SET speed.

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