Thermal resistance characterization of materials for Phase-Change Memory

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Abstract

Since PCM programming involves heating and quenching operations, the functional behaviour of phase change memory (PCM) cells is modulated by the thermal response of their constituting materials and interfaces. Therefore, the knowledge of the thermal characteristics of materials for PCM is important for modelling and device optimization.

The thermal conductivity of Ge-Sb-Te alloys, SiO_2 and Si_3N_4 thin films were measured by the 3ω and by the photo thermal radiometry (PTR) techniques. A good agreement on results was found between the two techniques. PTR experiments on $Ge_2Sb_2Te_5$ (GST) films were also performed in-situ at different temperature up to 400C revealing the transition from amorphous to crystalline fcc to crystalline hcp phases. The GST thermal conductivity results to be constant at 0.2 W/mK for the amorphous phase, increasing for the fcc phase from 0.42 to 0.91 W/mK in the 140-300 C range and rising to 1.1-2 W/mK for the hcp phase (from 310 to 400C).

The measurements of different thicknesses from 40nm to 840nm enabled the extraction of the thermal resistance at films interfaces. The interface thermal resistance resulted to be in the range 2-10 $\cdot 10^{-8}$ m^2K/W, a significant high value, equivalent to a thickness of few tens of nanometers of good thermal insulator (i.e. SiO_2).