Chalcogenide Phase Change Materials for Nanoscale Switching

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Since the demonstration of threshold switching in chalcogenide alloys over forty five years ago, phase change materials have been extensively investigated for switching and data storage applications. Phase change switching is based on the reversible change between crystalline and amorphous states of a material and in many chalcogenides this change of state takes place in nanoseconds.

Phase change materials tend to be based on tellurium and nearly all prototype devices make use of a chalcogenide alloy of germanium, antimony and tellurium (GST). For several years, we have explored a less well known chalcogenides based on gallium lanthanum sulphide glasses (GLS). In 2004 we demonstrated GLS phase change functionality [1] and since then have explored compositional modifications leading to improved performance compared to conventional GST materials [2,3]. In this talk we introduce our most recent advances which include two new switching paradigms using planar chalcogenides thin films at nanoscale thicknesses.

In the first, by we demonstrate substantial resonance frequency tuning in a photonic metamaterial hybridized with an electrically/optically switchable chalcogenide glass. The amorphous and crystalline transition brings about a 10% shift in the near-infrared resonance wavelength of an asymmetric split-ring array, providing transmission modulation functionality with a contrast ratio of 4:1 in a device of sub-wavelength thickness [4]. In the second, we demonstrate a high voltage threshold switching event approximately 60 Volts above the well know Ovshinsky threshold and which in preliminary trials cycled repeatedly between the conductive and resistive states.

The ultimate objective of our work program is to make significant positive step change in application of chalcogenides in optoelectronics and in this way help to enable the next evolutionary stage of their development, the merging electrons and photons at the nanoscale.

1. UK Patent GB 2 433 647, Filed 20.12.2005
2. R.E.Simpson et al, *Applied Physics Letters* 2008 Vol.92 (14)
3. R.E.Simpson et al, *Electronics Letters* 2007 Vol.43 (15) pp.830-832
4. http://arxiv.org/abs/0912.4288