Volatile and Non-volatile Switching in Dielectric Metamaterials

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Abstract

The next phase of the photonic technological revolution will be driven by the development of nanoscale/nanostructured switchable and nonlinear materials as functional platforms for integrated nanophotonics. We report here on recent advances in the development of versatile, planar photonic metamaterial solutions to provide a new generation of nanoscale all-optical switching and memory 'meta-devices'.

Summary

We introduce all-dielectric optomechanical metamaterials [1, 2], wherein optical forces drive changes in structural configuration, as a flexible paradigm (inherently free of Joule losses) for achieving strong optical nonlinearity, optical bistability and asymmetric transmission at intensity levels of only a few hundred μW/μm^2.

We show that optically-induced phase transitions in germanium antimony telluride (GST) – a member of the chalcogenide alloy family upon which re-writable optical disc and phase-change RAM technologies are based – provide for the engineering of non-volatile metamaterial transmission/reflection modulators of sub-wavelength thickness for the near- to mid-infrared range [3]. And we report on the non-volatile switching of amorphous chalcogenide glass thin films to the crystalline phase through a through a number of reproducible, discrete, optically distinguishable intermediate states, and on the re-amorphization of these films using femtosecond laser pulses. We demonstrate progressive switching of domains ranging in size from 200 down to 1 μm^2 through at least eight distinct partially crystalline states using ultrafast optical excitation and explore applications potential to high-base (>binary), high-density data storage, all-optical signal modulation, image processing and non-Von Neuman computing.

References

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