Active, Switchable and Nonlinear Photonic Metamaterials

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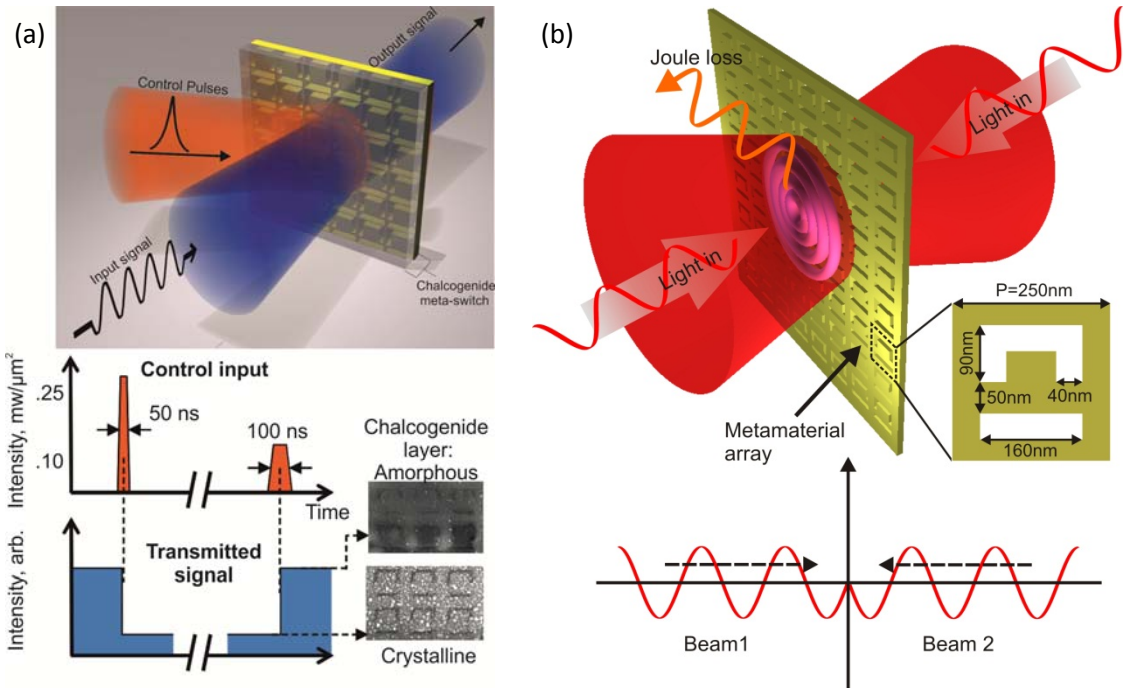
The next photonic revolution will be fuelled by a dependence on metamaterials - radically new types of artificial electromagnetic media with unusual and useful functionalities achieved via structuring on the sub-wavelength scale. By advancing the physics of the generation and manipulation of light in nanostructures, such media offer ground-breaking solutions for telecoms, energy and light generation, imaging, lithography, data storage, sensing, and security and defence applications.

We report on recent results in the development of active, switchable and nonlinear metamaterials surpassing natural media as platforms for optical data processing, including phase-change, opto-mechanical and coherently controlled 'meta-devices'.



Photonic 'Meta-devices': (a) All-optical, non-volatile, chalcogenide metamaterial switch - delivers high-contrast VIS to mid-IR transmission/reflection modulation in device structures down to $^{\sim 1}/_{27}$ of a wavelength thick. (b) Control of light-by-light *without* nonlinearity - two coherent light beams of arbitrarily low intensity can interact on a metamaterial of nanoscale thickness such that one beam modulates the other.