New 'Mixed-Mode' Optoelectronic Applications Possibilities using Phase-Change Materials and Devices

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To date the main applications of phase-change materials and devices have been limited to the provision of non-volatile memories. Recently, however, the potential has been demonstrated for using a phase-change approach for the provision of entirely new concepts in optoelectronics, including phase-change displays, integrated phase-change photonic memories, optical modulation and optical computing [1-3]. Such novel applications are enabled by the ability of phase-change devices to operate in a 'mixed-mode' configuration, where the excitation is provided electrically and the sensing is carried out optically, or vice-versa. Exploitation of this mixed-mode is made possible in phase-change materials due to the large and simultaneous changes that occur in both refractive index and electrical resistivity on transformation between amorphous and crystalline states. In this paper, based on studies part-funded by the NSF Materials World Network, we present recent results of the use of such mixed-mode operation to provide new applications, including a demonstration of phase-change optoelectronics devices that can be used to make ultrathin all-solid-state colour displays of ultrahigh resolution [1], and hybrid integrated phase-change photonic circuits that offer both a low-power, multi-level memory capability and a computing functionality [2,3]. As so often mentioned by the late (and sadly missed) Stanford Ovhinsky at previous MRS meetings [4], phase-change materials have the potential to provide us with so much more than simple digital memory - a potential that we are now beginning to realize and exploit.

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