Spin lasers and spin communication

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Advances in spintronics, recognized by the 2007 Nobel Prize in Physics, have enabled over the last decade nearly a 1,000-fold increase in the capacity of computer hard drives in metal-based structures which utilize magnetoresistive effects [1]. However, this may only be the tip of the iceberg. The control of spin and magnetism in a wide class of materials and their nanostructures, has the potential for a much broader impact. Spin-polarized carriers generated in semiconductors by circularly polarized light or electrical injection, can also enhance the performance of lasers, for communications and signal processing. While such spin-lasers (usually realized as vertical surface emitting lasers) already demonstrate a lower lasing threshold current [2-6] for the steady-state operation, the most promising opportunities lie in their dynamic operation. We predict that hat the spin modulation can improve their performance (as compared to conventional lasers): from enhanced bandwidth and improved switching properties, to vanishing transient chirp [1,7,8]. One of the modulation schemes we propose relies on the spin polarization modulation at a *constant* charge current [1,7]. This principle can also be applied for novel interconnects implemented in silicon nanowires [9]. If spin, rather than voltage, encodes information, then the wires remain charged indefinitely where the constant charge current is used to drive the information but not to carry it. This scheme is free of dynamical transmission line effects, electromigration problems, and the need for wire shielding. We estimate that an effective bandwidth of such silicon spin interconnects is two orders of magnitude greater that what is currently feasible [9].

Work supported by AFOSR, ONR, NSF-ECCS, and DOE-BES.

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