Photonic Integration from a spintronic and magnetic perspective

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This presentation will address the opportunities for the integration of spintronics with photonics (Figure 1). Novel schemes for controlling the ferromagnetic state at femtosecond time scales by pulsed laser excitation have received great interest. By driving systems into the strongly non-equilibrium regime, it has been shown possible not only to quench magnetic order, but also to switch the magnetization by single laser pulses – so-called all-optical switching (AOS). It is being envisioned that combining the two fields could pave the way to a new class of hybrid spintronic-photonic devices, in which data is copied between photonic and magnetic (spintronic) domain without any intermediate electronic steps, leading to ultrafast and highly energy-efficient IT solutions. Other motivations for such integration come from the inherent difficulty to make a dense, fully photonic memory, and challenges faced in realizing an integrated optical isolator, for which solutions might be provided by magnetism and magneto-optics, respectively.

After a brief introduction into photonic integration and identifying different integrated photonic platforms, opportunities for spintronic-photonic integration will be sketched. Next, recent progress on scientific issues that are considered key for realizing the envisioned technology will be discussed [1]. Examples of progress towards integrated spintronic-photonic devices will be presented, including current-induced domain wall motion in Pt/Co/Gd-based conduits that display efficient AOS [2] with domain-wall velocities over 2000 m/s [3], AOS of MTJs [4], as well as on-chip magneto-optical reading of 300 x 400 nm^2 magnetic elements structured on top of InP photonic waveguides [5]. Moreover, a first proof-of-concept demonstration of on-chip AOS as realized in a Si_3N_4 photonic integrated circuit will be discussed. Finally, to further reduce the device footprint and increase data densities, near-field plasmonic approaches will be inevitable. Recent device simulations on using photonic cavities and plasmonic nano-antennas for sub-diffraction limited optical writing and reading [6], as well as using wavelength division multiplexing strategies [7], provide inside into pushing the ultimate performance.

References

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Figures

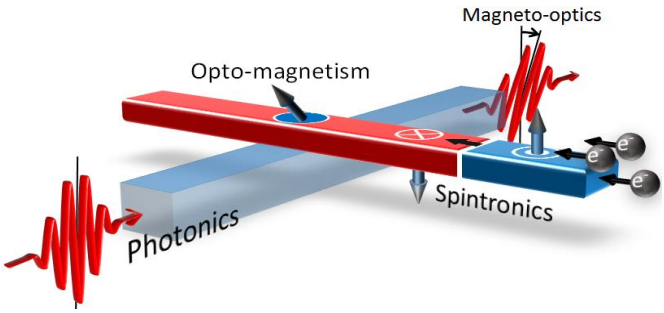

Figure 1. Schematic representation of spintronic-photonic integration.