Considering memory functionality for planer wave-guide structures with photo-magnetic materials

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Form of an optical memory unit is illustrated schematically in Figs. 1(a) and (b); (a) Mach-Zehnder interferometer (WG-MZI) and (b) WG splitter/selector. In the present work, we concentrate on type (a). It consists of an input port A, an output port B, an optical trigger port C. The intensity of the outgoing light pulse is determined by the interference condition at point B', namely, the phase difference, $\phi_1 - \phi_2$, between the branches 1 and 2, respectively. In the present case, we aim at controlling ϕ by the magnetization-vector-dependent refractive index in the WG region that is adequately coupled with magneto-optical (MO) layers, $\boldsymbol{M}_1$ and $\boldsymbol{M}_2$; $\boldsymbol{M}_1$ is regarded as an active layer whereas $\boldsymbol{M}_2$ as a reference layer. A light pulse entering from the port C takes the role of realizing ultrafast, non-equilibrium magnetic states with optical excitations through the bending loss mechanism, and triggering a change in direction of $\boldsymbol{M}_1$.

Model calculation on the basis of standard interference equation has been carried out, which is summarized as follows:

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$$\frac{P_{out}}{P_{in}} = \frac{1}{2}\exp\left(-\alpha_{\uparrow}\cdot L_M\right)\cdot\left[\left\{\frac{1+exp(-\Delta\alpha\cdot L_M)}{2}\right\} + \exp\left(-\frac{\Delta\alpha}{2}\cdot L_M\right)\cdot cos\left[\pi\left\{(2N-1)+\frac{2\Delta n_M}{\lambda_0}\cdot L_M\right\}\right]\right]$$

The first term concerns with absorption loss, whereas the second term interference. Here, $\Delta\alpha$ expresses *effective*, magnetization-direction dependent optical loss, namely the *effective* Faraday ellipticity, Δn_M represents the difference in the *effective* optical refractive index caused by the non-parallel magnetization configuration, namely the *effective* Faraday rotation, and L_M the optical length of magneto-optical region. Concrete model calculation assuming the use of ultrathin Co-Pd multilayers, one of the photo-magnetic materials systems, has suggested that intensity variation between parallel and anti-parallel $\boldsymbol{M}_1$ and $\boldsymbol{M}_2$ configurations is in the order of 10^{-4}, which is determined in part by the absorption loss. Reduction of absorption loss without deteriorating efficient photo-excitation should be carefully considered.

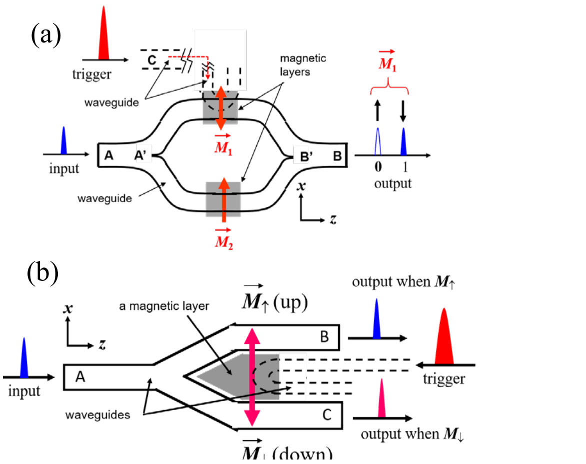

Fig. 1 (a) MZI- and (b) splitter-type memory cells.

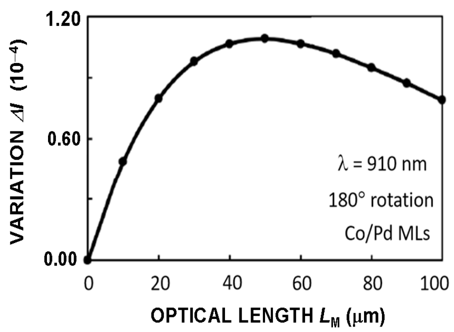

Fig 2 Variation of output light intensity ΔI as a function of optical length.