Ultrafast Faraday Rotation In Magnetophotonic Microcavities

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Faraday effect is a non-reciprocal optical phenomenon that can be greatly enhanced in multilayered structures due to multiple reflection interference [1]. A layered optical material can modulate electric field amplitude and phase of a femtosecond pulse in space and time. If a multilayered medium is illuminated by short laser pulses, non-steady behavior of Faraday rotation can be found on the timescale of pulse duration [2]. For example, Faraday rotation of the leading part of the pulse can differ from that of its tail and from a steady-state value. Moreover, Faraday rotation can both increase and decrease in time depending on interference conditions for a particular pulse central wavelength. In this work femtosecond dynamics of Faraday rotation is demonstrated experimentally in magnetophotonic microcavities (MMC) and thin magnetic films.

The experimental technique used in Ref. [3] was modified for time-resolved magneto-optical measurements. Fig. 1 shows spectral characteristics of time dependences of Faraday rotation in the MMC (a) and 16-μm-thick iron garnet film (b). The MMC was formed from a λ/2 magnetic Bi:YIG cavity layer placed between two Bragg reflectors consisted of 5 pairs of λ/4 alternate SiO_2/Ta_2O_5 layers.

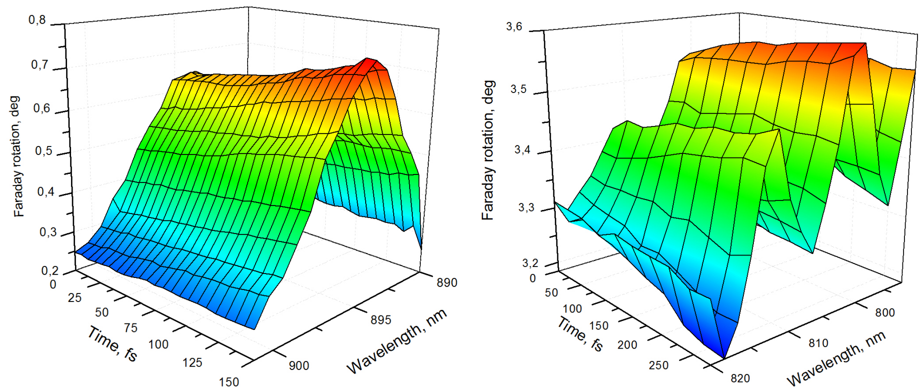

Fig. 1 Faraday rotation time dependences in MMC (a) and thin magnetic film (b).

The Faraday rotation in MMC growth is much faster than in thin film due to high Q-factor of the structure. While time dependence in MMC is increasing, that in the thin film can decreases as well for some spectral regions depending on the interference conditions. This fact is explained by phase relations between pulses due to multiple-reflection interference arising from constructive or destructive phase summation. The numerical results are in good agreement with the experiment.

References

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