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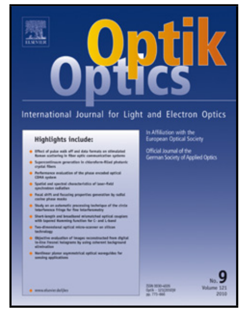

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Magneto-optical switching in microcavities based on a TGG defect sandwiched between periodic and disordered one-dimensional photonic structures

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Abstract
The employment of magneto-optical materials to fabricate photonic crystals gives the unique opportunity to achieve optical tuning by applying a magnetic field. In this study we have simulated the transmission spectrum of a microcavity in which the Bragg reflectors are made with silica (SiO_2) and yttria (Y_2O_3) and the defect layer is made with TGG ($Tb_3Ga_5O_{12}$). We show that the application of an external magnetic field results in a tunable splitting of the defect mode of the microcavity. In the simulations we have considered the wavelength dependence of the refractive indexes and the Verdet constants of the materials. A tuning of the defect mode of about 22 nm with a magnetic field of 5 T, at low temperature (8 K), is demonstrated. Furthermore, we discuss the possibility to tune a microcavity with disordered photonic structures as reflectors. In the presence of the magnetic field such microcavity shows a shift of resonances in a broad range of wavelengths. This study presents a method of contactless optical tuning.

Keywords: photonic crystals; magneto-optical properties; magnetic field.

Introduction
Photonic crystals are among the most interesting structures in optics, that give the possibility to transmit or reflect only certain energy ranges of the electromagnetic radiation. The energy region that is reflected by the photonic crystal is the so called photonic band gap [1–4]. A large variety of materials can be employed for the fabrication of photonic crystals [5]; also photonic crystals based on plasma [6,7] and superconductor materials [8] have been demonstrated. A topic, which is attracting increasing attention, is the active tuning of the photonic band gap. The most simple external stimulus that can be employed for such tuning is the electric field, as described in a recent and exhaustive review article [9]. To report some examples of electro-optical tuning, electro-active polyferrocenylsilane based opals and inverse opals with a broad tunability have been reported [10,11]. A liquid crystal infiltrated one dimensional photonic crystal showed a band gap shift of 8 nm by applying a field of 8 V [12,13]. Moreover, with a silver nanoparticle/titania nanoparticle based one dimensional photonic crystal, a band gap shift of 10 nm with 10 V applied voltage has been achieved [14]. The employment of electric contacts is necessary to apply an external electric field,. To achieve a tuning of the photonic band gap without electric contacts, the application of a magnetic field is a promising way [15–18]. In fact, in recent years interesting works were reported on magnetophotonic crystals [19–22]. In this work, we focus on the effect of microcavities on the light transmission spectrum in presence of an external magnetic field using clockwise and counter-clockwise polarizations. We simulate the transmission spectra of