Exhibition of gyrotropy in photonic crystals

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Photonic crystals consisting of magnetooptical materials (magnetophotonic crystal of MPC) often exhibit unusual magnetoptical properties. It is well-known that dilution of magnetooptical (MO) material, namely manufacturing MPC where the volume fraction of the MO material is significantly smaller than unity, may significantly enhance the MO Kerr, Faraday and magnetorefractive effects [1].

In this communication, we focus our attention on 1D PC because of their comparative robustness in manufacturing and of their comparative insensibility to losses. We produce a unified explanation of the enhancement of MO effects in different resonant structures, such as MO defect in 1D PC, the Tamm state at the interface 1D PC-1D MPC, a slab of 1D MPC. For this purpose we generalize the Airy's method to treat multilayer structures, taking into account that the eigensolutions to the Maxwell equations in PC are the Bloch waves with complicated intracellular structure.

It is also shown that some intracellular feature of the Bloch waves in MPC may lead to many effects unobserved in usual magnetoordered crystals: e.g. enhancement of MO effects, formation of new band gaps inside the Brillouin zones, the Borrmann effect in MPC.

Influence of plasmonic resonance is discussed.

It turns out that in spite of natural weakness of MO phenomena the effects caused by magnetization of MPC may be of the order of unity: the magnetic super-prism effect [2], the controllable Tamm state [3] etc.

References

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