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Reflectance of 1-D magnetic photonic crystals with different arrays of thin films

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The interest in photonic crystals (PCs) has increased manifold, because of their optical analogies to semiconductors and their potential to revolutionize photonics. This work concerns the reflectance of 1-D magnetic photonic crystals (MPCs), consisting of dielectric Al_2O_3 and magnetic Bi:YIG layers.The optical thickness is designed to be one-quarterwavelength for each layer. The following structures, which contain 24 layers in total with or without structural defects, are considered; (a) $(NM)^{12}$ and $(MN)^{12}$, (b) $(MN)^6(NM)^6$ and $(NM)^6(MN)^6$, (c) $(NM)^3(MN)^3(NM)^3(MN)^3$ and $(MN)^3(NM)^3(MN)^3(NM)^3$, and (d) $(MNNM)^6$ and $(NMMN)^6$. N denotes Al_2O_3 layer, while $M$the magnetic Bi:YIG layer. It is shown that the structures without structural defect exhibit the same results regardless of the sequence of layers. A photonic bandgap (PBG), which yields an extremely low transmittance and is centered nearly at the designed wavelength, is apparently observed in the transmittance spectrum. For the 1D-MPCs with a structural defect, such as thegroup (b), a defect mode, indicated by a high transmittance, is introduced within the PBG region. The structure with a dielectric defect layer provides a relatively low transmittance at the defect mode but a narrower PBGthan the structure with a magnetic defect layer. It seems that more defect modes can be produced by introducing more defect layers in the structure. In case of 1D-MPCs with many structural defects, the defect modes can be connected with each other, and a wide "roof" with high transmittance is formed in spite of the fluctuation indicated by small humps that correspond to each defect mode in the PBG. Certain magneto-optical (MO) effects in the 1-D MPCs are induced, due to the off-diagonal components ofdielectric tensor of the magnetic medium. For the structures without a defect layer, the coupled transmittance is relatively high at the right edge of PBG, while for the structures containing defect layers an enhanced coupled transmittance is observed at each defect mode. This enhanced coupled transmittance can be attributed to the localization of light, which occurs at the defect modes. Different MO results are also observed for the structures with different structural defects.