Preparation and properties of two-dimensional magnetophotonic crystals

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Two-dimensional magnetophotonic crystals (2D-MPCs) with rare-earth iron garnet were formed by the sol-gel method with Al_2O_3 plates (alumina) with periodic nano-scaled porous structures. The sol solutions of nitrates of Bi, Y and Fe dissolved in ethylene glycol were used as the liquid precursor of garnet. The sol-gel reaction proceeds by elevating temperature at 80 degrees C while stirring the solution in a nitrogen flow. After reaching an appropriate viscosity, the solution was cooled to room temperature and the resultant gel was poured into the alumina plate with self-organized nano-scaled honeycomb periodic porous structure.

The porous alumina was formed by combining the successive anodic oxidation process of Al and the chemical polishing process as follows: Though the anodic oxidation of Al with 0.5 mm thick in nitric acid under a constant voltage, porous alumina layer with approximately 60 micron-meter thick was formed on the Al plate. The alumina layer was removed chemically and the resultant Al plate was etched chemically so as to remove slightly the nano-scaled honeycomb patterns. The anodic oxidation of the resultant Al plate was then achieved and the alumina layer thus formed was again removed. By repeating this process for appropriate times, we obtained alumina layers with 2 micron-meter thick having considerably periodic porous structures.

The gel solution poured into the above alumina template was post-annealed at 700 degrees C and the magnetic nano-structures with single garnet phase was obtained. After the post-annealing, the alumina template was removed chemically and the magnetic nano-scaled periodic poles surrounded by air were obtained. The removal of alumina template was done so as to make large difference in optical refractive indices between the magnetic nano-scaled poles and the surrounding material, which is essential for opening clearly the photonic band gap.

Another process is fabricate 2D-MPC of Bi:YIG with hole structure. The Bi:YIG films were prepared by rf-magnetron sputtering. By using the mask of the porous alumina template, we etched the Bi:YIG film by Ar ion beam gun. We confirmed the hole-structured Bi:YIG film.

The detail of optical and magneto-optical properties is presented at the conference.