

Coating of ferrite on SiO₂ spheres for three-dimensional magneto-photonic crystal

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This work is aimed at preparation of the three-dimensional magneto-photonic crystal – the three-dimensional dielectric lattice with magnetic materials inside. However, utilizing submicrometric magnetic spheres has the many difficulties: fabrication the spheres of the equal size, agglomeration of spheres due to magnetization. We propose coating thinly submicrometric spheres with magnetic ferrite oxides by using reported solution process [1]. By using the SiO₂ spheres of the equal size, we prepared the coated spheres with the same size.

A reaction solution (500 μ l) of FeCl₂ (13 – 76 μ mol) + FeCl₃ (4 – 67 μ mol) which contains SiO₂ spheres of 10 mg dropped to a pH adjusting solution (500 μ l) of ammonia (3 – 15 %) and placed into a micro tube (1.5ml in volume) in the open air. We varied the ratio of Fe³⁺ / Fe²⁺ in the reaction solution from 5% to 500 %. The total amount of metal ions was fixed at 80 μ mol. We used SiO₂ spheres with diameter of around 300 nm. This standard deviation is smaller than at 5%. We performed at room temperature.

This technique occurs jointly the following processes. Immersing a substrate with OH groups on its surface in a reaction solution containing iron ions are adsorbed on the surface mediated by OH groups, releasing H⁺. When we introduce an oxidizing reagent such as NaNO₂ or air (O₂), some of the Fe²⁺ ions are oxidized to Fe³⁺. Then the Fe²⁺ and Fe³⁺ ions are adsorbed on the surface. This causes formation of ferrite if it satisfied a pH region of Fe₃O₄ in potential-pH equilibrium diagram [2]. The Fe₃O₄ fine particles were synthesized at pH > 6, as revealed by X-ray analysis. These magnetite coating samples can be separated by the permanent magnet. The diameter of Fe₃O₄ fine particles is about 30 nm when r = 5 % and pH = 8.4. The diameter of these particles decreases about 10 nm by increasing up to r = 20 % in the same pH region. It was found that a decrease of the coated particles size can be made as low as the size of 5 % of LATEX spheres diameter. Therefore, one may use these particles for preparation a three-dimensional magneto-dielectric structure.

References

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