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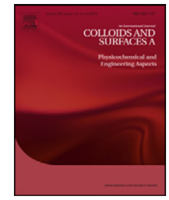


Fabrication and optical properties of silica shell photonic crystals

Qingsong Jiang, Jing Zhong, Xiao Hu, Feifei Song, Kuan Ren, Helin Wei*, Lin Yi*

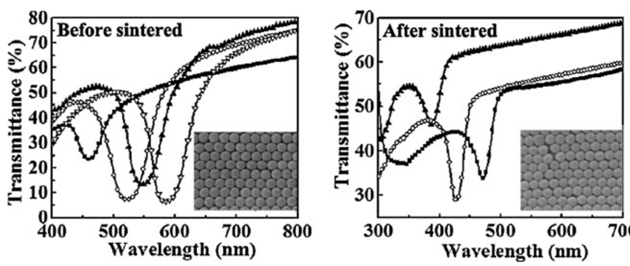
School of Physics, Huazhong University of Science and Technology, Wuhan, Hubei 430074, China

HIGHLIGHTS

- ► Polystyrene-core silica-shell spheres are self-assembled into photonic crystals.
- ► The silica shell photonic crystals are fabricated by sintering process.
- ► The optical properties of photonic crystals of core-shell spheres are investigated.
- ► The optical properties of silica shell photonic crystals are investigated.

GRAPHICAL ABSTRACT

The silica shell photonic crystals are fabricated by sintering the photonic crystals composed of polystyrene-core silica-shell spheres, and the optical properties of photonic crystals have been investigated by tuning silica shell thickness.



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ABSTRACT

The relationship between silica shell thickness and optical properties of three-dimensional photonic crystals (3D PCs) is studied in this work. Core-shell spheres are synthesized by the modified Stöber method and self-assembled into 3D PCs through a simple improved vertical deposition method. Silica shell PCs are fabricated by sintering the PCs composed of the core-shell spheres. The morphologies and microstructures of PCs are identified by scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The transmission spectra of PCs are measured by UV–vis spectrum measurements (UV). The results show that the positions of Bragg diffraction peaks are shifted to a longer wavelength with the increase of silica shell thickness. The shift range of peak positions for silica shell PCs is wider than that for PCs of core-shell spheres. The main reason for this is because the variation range of effective refractive indices for silica shell PCs becomes larger than that for PCs of core-shell spheres.

1. Introduction

Photonic crystal, an artificial periodic structure whose dielectric function is periodically modulated, can inhibit electromagnetic waves with certain frequencies propagation through specific crystal orientations [1,2]. If the electromagnetic waves of any polarization spreading in any direction from any source are prohibited in photonic crystal for some frequency range, this photonic crystal has a full photonic band gap [3]. Photonic crystals have many potential technological applications, such as optical communications, photonic computing, switching, sensing, lasing, and solar cells [3–7].

For decades, PCs composed of monodisperse single colloidal spheres (such as silica spheres and polystyrene spheres) [8–11] or composite colloidal spheres (such as core-shell spheres) [12–19] have been extensively researched. The close-packed colloidal crystalline arrays of silica (SiO_2) spheres coated with titania were fabricated by Ishii and co-workers [12]. Zinc sulfide-coated polystyrene (PS) core-shell spheres and hollow zinc sulfide spheres were used by Ratna and co-workers [13] to fabricate PCs. They found that the peak positions of the reflection spectra were shifted to a longer

* Corresponding author. Fax: +86 27 8755 7705.
E-mail addresses: hlwei@mail.hust.edu.cn (H. Wei), yilin@mail.hust.edu.cn (L. Yi).

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