【QS-04】

3-D Photonic Bandgap Structures of Colloidal Nanospheres

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Photonic crystal is an artificial optical material with a periodic dielectric potential, hence exhibiting a band-gap for a propagating electromagnetic wave. We fabricated photonic crystals possessing 3-D fcc opal structure from silica and polystyrene nano-spheres. Silica 3-D photonic crystals are self-assembled on a flat glass by evaporating the solvent in the nano-sphere suspension at the room temperature. We also fabricated 3-D opaline structures of polystyrene spheres (175 nm 528 nm in diameter) by centrifuge method. The fabricated photonic crystals exhibit opalescent colors under white light and they show a clear diffraction peak dependent on the incident angle of the light beam. In Figure 1, the SEM pictures show that the fabricated opals have a face-centered cubic structure with the (111) face parallel to the surfaces of the substrate.

Transmission spectrum of the fabricated photonic crystal in the visible and near-infrared regions is measured at different incident angles to find the distinct Bragg peaks, analysis of which further confirmed the fcc structure of the photonic crystal. From the optical microscopic image, we find that the opal domain of silica 3-D photonic crystal varies from 30㎛ to 125㎛ in size. In order to relate the observed Bragg peaks with the microscopic arrangement of silica nano-spheres, we introduced the scalar wave approximation, where the electric field in the medium is treated as a scalar rather than a vector quantity. It is found that the theoretical prediction of the position of band-gap is in a good agreement with the experimental measurement.

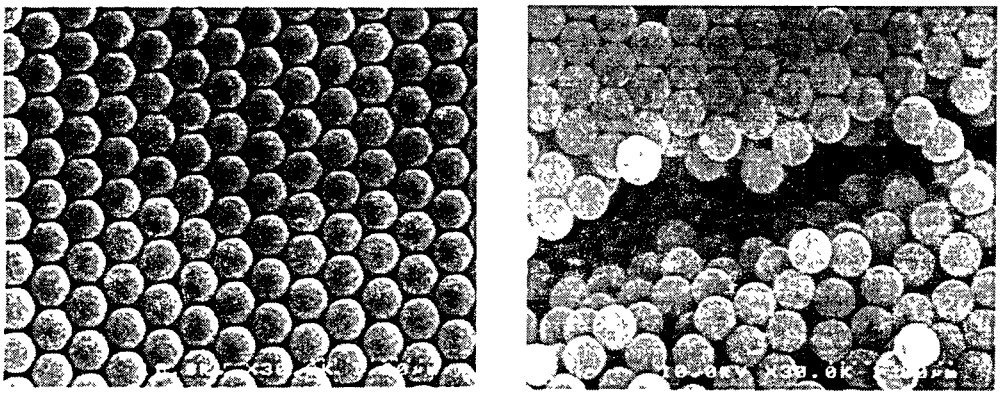

Fig.1 SEM images of opals fabricated in 12 micron thick cell from 356 nm polystyrene spheres.

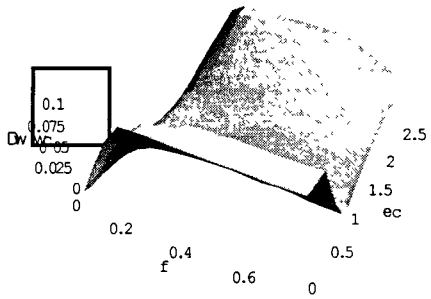

Fig.2 Dependence of the normalized stop bandwidths on the volume fraction and the dielectric contrast along L-point

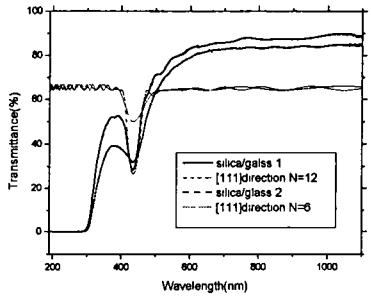

Fig.3 Comparison between experimental and calculated transmission spectra at normal incidence

This work is financially supported by KOSEF through q-Psi SRC program.