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Angle dependent spectrum measurement of opal like structure described by Bragg-Snell diffraction and perturbed photonic band structure

Optical diffraction of opal, a colloidal photonic crystal, can be predicted by Bragg-Snell diffraction and photonic band structure. Theoretical prediction and optical measurement are frequently slightly different due to distance variation of particle packing. In this research, opal of 310 nm polystyrene beads was fabricated by self-assembly process and optically investigated in transmission spectra at varied angles. The measured spectra had less agreement to the Bragg-Snell prediction at large angle of detection. To explore influence of packing distance on optical response, photonic band structures were numerically simulated via plane-wave expansion method at presence of perturbed length in primitive lattice vectors. Extending each primitive vector with fixing others provided a different eigenfrequency of the first photonic band, although they had a symmetrical perturbation on (111) face-centered cubic. Perturbation on lattice length became much strong when the disturbing direction was out of eigenstate orientation plane.

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