Reflectivity of a Periodic Structure of Self-Assembled Silica Micro-Spheres

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The reflectivity of a micro periodic structure assembled with silica micro-spheres in a close-packed structure is investigated. The micro periodic structure can be easily fabricated over a large area using the colloidal technique. The photonic band structure of the face-centered cubic lattice of dielectric spheres was designed using MIT Photonic Band (MPB), a software used for the calculation of the definite-frequency eigenstate of Maxwell's equation in photonic crystals. From the computational result, the diameters of the silica spheres in the periodic structures were decided to be 2 and 3 μm, in order to control the thermal radiation in the transparent wavelength area of silica. Samples were fabricated on a Si wafer. Silica micro-spheres formed a monolayer self-assembly at the air-liquid interface. The three-dimensional close-packed structure of spherical silica was fabricated with a stacking monolayer. The crystal structure was observed with a Scanning Ion Microscope (SIM). The samples have dislocations and lattice defects, but silica micro-spheres form a close-packed structure over almost the entire surface of the wafer. The periodic structure grows to the [111] direction; the substrate is oriented with the stacking layers. The spectral reflectivity of the samples is measured using a Fourier Transform Infrared Spectrometer (FT-IR). The spectral reflectivity is enhanced at a specific wavelength, depending on the sphere size, and it is sharpened and strengthened with the thickness of the periodic structure. The peak wavelength can be evaluated using the modified Bragg's equation, taking into account Snell's law of refraction. The experimental results agree well with the analytical results. In addition, the periodic structure of the silica spheres with 3 μm diameters is fabricated on that with 2 μm diameters. The spectral reflectivity of the sample is measured by FT-IR. The two peaks in the wavelength are measured to be corresponding to the peak wavelengths of each periodic structure. These results can be applied to the advanced control of thermal radiation.