2-mm-diameter beams from an He-Ne and/or argon-ion laser and two types of samples: (a) microscope cover-glass plates of 150 μm thickness and (b) Fabry–Perot plates of 0.5 mm thickness. The only difference between samples (a) and (b) was that, whereas the Fabry–Perot plates had only SSR with rms height h, the ordinary glass plates contained the same size SSR with the addition of LSR with rms height σ. The LSR is a consequence of the deviation from perfect planarity of the glass surface, which was measured to be an average of 0.01–0.1 μm, on a horizontal scale of order 1 mm. The presence of LSR of this size added ~10–50% to the total rms height of roughness, $h_t \approx (h^2 + \sigma^2)^{1/2}$, which means that in both cases, h_t remains the same order of magnitude (much smaller than the wavelength λ). The measured scattered intensity from the two samples, however, showed completely different far-field interference patterns. In the patterns obtained from the Fabry–Perot plate, the positions of interference rings are independent of the angle of incidence, θ_{in}. Their brightness, however, oscillates periodically as θ_{in} is varied (Figs. 1a and 1b). In stark contrast, in the ring pattern obtained from the ordinary glass plates, the position of the rings depends on the θ_{in}. In fact, one of the bright rings (an interference maximum) remains attached to the specular reflection direction, and both move with nearly constant brightness as the θ_{in} changes (Figs. 1c and 1d).

A comparison of the measured scattered distribution with one calculated in the first Born approximation[2] shows that there is a good quantitative agreement with the measurements of the scattered intensity from the slightly rough Fabry–Perot plates, but it completely differs from the intensity distribution observed in the experiments with ordinary glass plates.

To obtain agreement with the experiment, we had to take into consideration that the effect of LSR is actually twofold: it scatters light at small angles $\theta_s \sim \lambda/L$, and it destroys the phase coherence of successive reflections during the propagation of the singly scattered waves inside the dielectric layer. We have obtained an explicit expression for the scattered intensity distribution that describes quantitatively the results of both series of experiments.

In conclusion, the scattering diagram from a slightly rough dielectric film is extremely sensitive to long-scale corrugations of the interface. Even very small, smooth deviations of the average surface of a slightly rough layer from a perfect plane that do not affect the total rms roughness drastically change the interference pattern.

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QThG6

Fabry–Perot-type resonances in metallic photonic crystals

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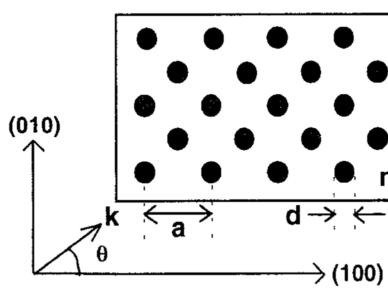
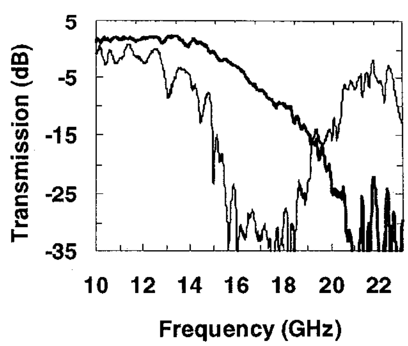
Metallic photonic crystals (MPCs) with face-centered tetragonal (FCT) lattice composed of rods[1] and metallodielectric photonic crystals with face-centered cubic (FCC) lattice composed of spheres[2] have already been investigated at microwave frequencies. In our experiments, we investigated an MPC in the microwave regime. The MPC has an FCC Bravais lattice composed of steel spheres, with diameter **d** = 0.635 cm. The lattice was formed along the (100) direction by stacking alternating layers of spheres. One layer consists of spheres packed as shown in Fig. 1, which depicts the (001) plane (top view) of the MPC. Our MPC consisted of 11 layers or five-unit cells. The lattice constant was **a** = 1.5 cm. The supporting dielectric material was air-doped polystyrene with a refractive index **n** = 1.16. Such a low refractive index for the supporting dielectric material allowed us to realize the first, to our knowledge, MPC with its spheres almost floating in the air. Figure 2 shows the transmission spectrum through the MPC along the (100) crystal direction. The lower edge of the stop band starts at 13.0 GHz. The center frequency for the stop band is at 17.25 GHz, which compares favorably with the normal ($\theta = 0°$) incidence Bragg condition frequency. The upper edge of the stop band is at 21.5 GHz. Therefore, the width of the stopband is 50% of the center frequency, which makes our MPC suitable for microwave applications. Ignoring the oscillations, the maximum rejection at the band center is 35 dB, corresponding to a rejection of 7 dB per unit cell.

One aspect of the MPC is noteworthy: the transmission below and above the stop band is unity. This is quite remarkable for an MPC considering that a metallic surface would have reflected 99.97% of the incident radiation in the given microwave frequency range.

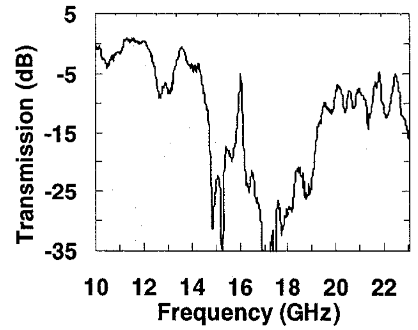
We also studied the effect of the incidence angle on the transmission of the MPC. Figure 2 shows the transmission spectrum through the MPC along the (110) crystal direction. For the (110) direction, the center frequency is at 24.3 GHz, which is close to the limit of our detection range. The PBG shifts toward higher frequencies, as expected from the Bragg condition on the center frequency.



QThG6 **Fig. 1.** Top view of the (001)-oriented face of the MPC.



QThG6 **Fig. 2.** Normal 0° (100) (thin solid line) and 45° (110) (thick solid line) incidence transmission through the MPC.



QThG6 **Fig. 3.** Normal 0° (100) incidence transmission through the MPC with the gap in the middle.

We later measured the transmission properties of the MPC with the Fabry–Perot-type cavity resonator. The separation distance is set to be **L** = 1.75 cm between the 2 parts (mirrors) of the MPC. Figure 3 shows the transmission spectrum of the MPC at low spectral resolution and along the (100) crystal direction. The spectrum in Fig. 3 is similar to the full MPC spectrum of Fig. 2, except for the Fabry–Perot-type mode. This is the first measurement, to our knowledge, of such a mode within an MPC composed of metallic spheres. The Fabry–Perot-type mode has a linewidth of 0.08 GHz and a quality factor of 200. The Fabry–Perot-type mode frequency of 16.02 GHz compares favorably with the resonance condition of $v_{FP} = c/4\pi Ln\,(2\pi \mathbf{m} - \phi)$, where **m** is the mode number, and ϕ is the total reflection phase of the two mirrors.[3] From the frequency of the resonance, the mode number is found to be **m** = 3 and the total reflection phase of the two mirrors $\phi = 300°$.

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QThG7

Nonlinear propagation of an optical beam in polymer waveguide with upconverted photobleaching

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Self-controlled optical-beam steering in nonlinear optical media has been intensively studied over the last three decades.[1,2] We show that refractive-index decrease on upconverted