crostrip line is 0.12 mm wide and has a characteristic impedance of 50 Ω. The aperture-coupling slot, etched in the ground plane, is 0.48 mm wide and 79.5 mm long. In order to maximize coupling, the microstrip line is extended beyond the middle of the slot by a length of 36 mm, which corresponds to a transmission-line electrical length of about a quarter wavelength. The other end of the microstrip line is transformed to a 50-Ω coplanar waveguide line, which is used for connection to a transmit/receive module. Some plated-through vias are added to the outer conductors of the coplanar waveguide to suppress parallel-plate modes. The measured and calculated 10-dB-return-loss bandwidth of the antenna is 100 MHz.

By eliminating the radiating patch and the upper membrane that supports it, and performing two other simple modifications, one can convert the two-membrane antenna described above to a paper-thin single-membrane antenna, shown in the lower part of the figure. One modification is to increase the slot length to 104.95 mm; the other is to extend the microstrip to 36.68 mm past the middle of the slot. With these modifications, the slot now becomes a half-wavelength radiator with a nearly omnidirectional radiation pattern. In one potential use, such a paper-thin antenna could be pasted on an automobile window to enable omnidirectional communication.

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monic mode locking: for example, by modulating the light at a frequency of 33 GHz and locking each 33rd optical mode, one would create a 1.089-THz pulse train. The high resonance quality factors ($Q$ values) of WGM optical resonators should make it possible to decrease signal-generation threshold power levels significantly below those of other optical-signal-generation devices.

An electro-optical modulator as proposed would be a triply resonant compound WGM device. The modulator would comprise a periodically poled LiNbO$_3$ WGM optical resonator stacked almost in contact with an Si WGM terahertz resonator. It would be necessary to use these two resonators because LiNbO$_3$ would afford the needed combination of high $Q$ for the optical modes and enough nonlinearity for efficient interaction between light and terahertz radiation, while Si would afford the needed high $Q$ for terahertz radiation.

Because Si absorbs light, it would be necessary to minimize penetration of light into the Si resonator. Because LiNbO$_3$ absorbs terahertz radiation more than Si does, the portion of the LiNbO$_3$ volume wherein the light and the terahertz radiation interact should be less than the volume of the terahertz mode. These requirements would be satisfied by, among other things, positioning the two resonators with a gap of $\approx 1 \mu m$ between them and utilizing evanescent-field coupling between the light and the terahertz radiation. The periodicity of the poling of the LiNbO$_3$ would be chosen to ensure the required matching of phases between the light and the terahertz radiation.

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