

A W-band Band-stop Filter Using Electromagnetic Crystal (EMXT) Surface

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An electromagnetic crystal (EMXT) is a periodic electromagnetic structure that exhibits band gap properties. The EMXT surface discussed here provides high surface impedance at its resonant frequency. Due to the unique properties, the high-impedance surfaces have been used in applications such as antenna ground plane, quasi-TEM waveguides, band-pass and band-stop filters (H. Xin *et al*, IEEE MWCL, vol. 13, 108-110, 2003).

In this work, a band-stop filter is proposed by loading the top and/or the bottom walls of a rectangular waveguide with EMXT surfaces, which has a band gap that can prevent electromagnetic wave from propagating inside the waveguide. Figure 1(a) shows a rectangular waveguide filter with its bottom wall loaded with an EMXT surface. The EMXT surface is created by placing capacitive periodic metal strips on top of a thin substrate with complete metallization on the back, as shown in Figure 1(b). The grounded substrate with vias provided inductive response that together with the capacitive strips forms a resonant structure. Additionally, an equivalent circuit model is introduced for the analysis of the proposed waveguide filter. The model is a superposition of responses from conventional rectangular waveguide and EMXT surface. Assuming wave propagation in z -direction, the metallic section behaves as TE_{10} mode that is represented by transmission line model. The non-metallic section is viewed as transverse discontinuity modeled by a parallel LC circuit coupled to a short-ended EMXT substrate by a transformer of 1:1 ratio. For experiment, the designed EMXT surface is fabricated on a Duroid 5880 substrate ($\epsilon_r=2.2$) with the following dimensions: $w=15\text{mil}$, $g=5\text{mil}$, $h=15\text{mil}$, and $r_0=3\text{mil}$. A prototype waveguide filter using the designed EMXT surface is characterized with rejection band centered at 96 GHz and a rejection level of 15 dB.

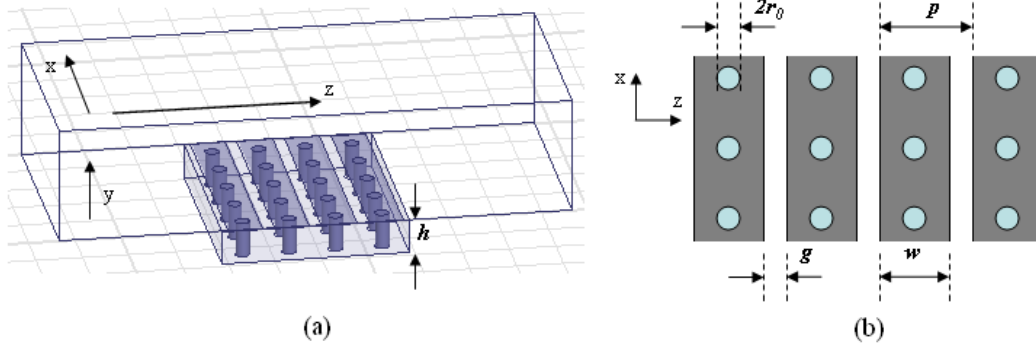


Figure 1. (a) A band-stop waveguide filter with bottom wall loaded with EMXT surface. (b) Top view of the EMXT surface.