3. OPTICAL MODEL OF A LIQUID-CRYSTAL PIXEL

The optical model is based on the usual twisted nematic (TN) configuration of most TFT-LCDs. The geometrical parameters of this setup are shown in Figure 3. The electric field transmitted by a TN device can be calculated by Jones algebra [5] as follows:

\[ E_0 = P_0 R(\psi_2) R(-\alpha) \text{TN}(\alpha, \beta) R(\psi_1) E_i, \]  

(2)

\( \psi_1 \) and \( \psi_2 \) are the angles between the polarizer and analyzer axes and the molecular director at the cell entrance, \( E_i \) is the electric field of incident light, \( P_0 \) is the Jones matrix for the analyzer, and \( R(\cdot) \) and TN are the rotation matrix and the matrix associated with the TN cell, respectively; \( \alpha \) is the rotation of the birefringent LC axis across the device (= 90°), \( \beta \) is the local LC birefringence, and \( \gamma \) is given by \( (\alpha^2 + \beta^2)^{1/2} \).

4. ELECTRO-OPTICAL MODEL OF AN a–Si TFT–LCD PIXEL

An electro-optical model to characterize TFT pixels has been prepared by merging the two models described above [6]. Several features have been tested on the model. For example, Figure 4 shows the evolution of the response, and the pixel capacitance \( (C_{lc} + C_{sh}) \) is increased. Sixteen gray levels can be obtained in this case.

5. CONCLUSIONS

An electro-optical model describing TFT–LCD pixels has been presented. The model allows the computation of the data signals required for the desired gray scale to arise. Optical variations due to a number of electric parameters can also be observed.

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FDTD ANALYSIS OF A NEW TRANSITION FROM COPLANAR WAVEGUIDE TO RECTANGULAR WAVEGUIDE

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ABSTRACT: A rectangular waveguide fed by a grounded coplanar waveguide (GCPW) is investigated using the finite-difference time-domain (FDTD) method. A path is used to couple energy to the rectangular waveguide (RW) by placing the waveguide opening around the patch. The coupling from the GCPW to the patch is accomplished via an open end. For a 10 dB return loss, a relative bandwidth of 14% is obtained for a GCPW-to-RW transition. A back-to-back GCPW-to-RW transition is analyzed, and it is found to have good insertion-loss characteristics, which verifies that power is indeed coupled to the waveguide. © 2001 John Wiley & Sons, Inc. Microwave Opt Technol Lett 29: 199–201, 2001.

Key words: FDTD; coplanar waveguide; transitions; rectangular waveguide

1. INTRODUCTION

An attractive way to feed an antenna is through electromagnetic coupling. Recently, it has been shown that microstrip patch antennas can be effectively fed by a coplanar waveguide (CPW) [1–8]. The use of a CPW rather than a microstrip offers several advantages. These include easy integration of series and shunt solid-state devices into the CPW, and lower radiation losses.
Recently, transitions from a microstrip line to a rectangular waveguide (RW) through aperture coupling have been proposed and characterized [9–11]. The main advantage of these transitions over conventional ones is the fact that waveguide structures are necessary only on the back side of the planar circuit [11]. A 20 dB return loss bandwidth of 16% was reported in [11].

In this paper, a rectangular waveguide fed by a grounded coplanar waveguide (GCPW) is investigated using the FDTD technique. A patch is used to feed a rectangular waveguide. The return loss is evaluated and presented as a function of frequency for different structures. The FDTD formulation is simple and well known [12], and thus only a brief description of this method is given in Section 3.

2. TRANSITION DESCRIPTION
In Figure 1, the geometry of a rectangular waveguide fed by a GCPW is shown. The feeding is accomplished through a patch which is directly fed by the open-end GCPW through electromagnetic coupling. It has been found in [8] that a CPW open end appears as a good excitation source, providing both an easy matching and the lowest level of back radiation at the resonant frequency. Alternatively, coupling to the patch, which in turn feeds the waveguide, can be achieved through an aperture in the ground plane separating the GCPW and the patch, as described in [1]. This requires separate substrates, which leads to more complex construction, heavier circuits, and difficulty in MMIC implementation.

3. FDTD METHOD
In this method, Maxwell’s curl equations are expressed in discretized space and time domains, and are then used to simulate the propagation of an initial excitation in a leapfrog manner [12]. To characterize any discontinuity, propagation of a specific time-dependent function through the structure is simulated using the FDTD technique. A Gaussian pulse is used here because it is smoothly varying with time, and its Fourier transform is also Gaussian centered at zero frequency. Following the time and space discretizations of the electric- and magnetic-field components, the FDTD equivalents of Maxwell’s equations are then used to update the spatial distributions of these components at alternating half-time steps. The space steps are carefully chosen such that integral numbers of them can approximate the various dimensions of the structure. As a rule of thumb, and to reduce the truncation and grid dispersion errors, the maximum step size is chosen to be less than 1/20 of the smallest wavelength existing in the computational domain. Then, the Courant stability criterion is used to select the time step to ensure numerical stability. Superabsorbing boundary conditions [13] have been applied at the top, bottom, front, and back walls.

4. RESULTS
First, for validation purposes, microstrip-fed rectangular waveguides, through an aperture, similar to those presented in [9], were analyzed. Figure 2 shows a cross section of one of these structures. Figure 3 shows the FDTD results compared to those published in [9]. The theoretical data in [9] were obtained using a modified spectral-domain technique in which a shielded microstrip line was assumed, while a microstrip in an open environment is considered here. This might explain the better agreement between the FDTD results and the experimental ones. Similar agreement has been found with the other structures included in [9].

Figure 4 shows the return loss for a conventional CPW-fed patch antenna, a GCPW-fed patch antenna, and a GCPW-fed RW. In the GCPW-fed patch antenna structure, the RW is removed, leaving the patch to radiate in free space. On the other hand, the RW and the lower ground plane, surrounding the patch, are removed in the conventional CPW-fed patch structure. A similar CPW-fed patch has been analyzed in [4] using the method of moments in the spectral domain. In that formulation, the longitudinal components of the electric field in the slots were neglected. Although, in principle, the technique can be extended to analyze wide slots, the integrals to be evaluated will become more complicated. Using the FDTD technique has the advantage that wide slots can be easily
considered without any further complications. Figure 4 shows that a 10 dB return loss bandwidth of 14% is obtained for the GCPW-to-RW transition.

To make sure that the power couples to the waveguide and is not radiated in space, a back-to-back transition has been analyzed with a 34.4 mm long rectangular waveguide. The scattering parameters of such a back-to-back transition are shown in Figure 5. The insertion loss is better than 3 dB in the range 11–12.3 GHz, which verifies that the power is indeed coupled to the waveguide from the GCPW. The resonance in $S_{11}$ seen at 10.8 GHz is due to the fact that the RW wavelength at this frequency is equal to the considered RW length connecting the two transitions (i.e., 34.4 mm).

5. CONCLUSIONS

A new transition from a coplanar waveguide to a rectangular waveguide has been proposed and analyzed using the FDTD technique. Specifically, results for an open-end CPW-fed rectangular waveguide have been presented. A 10 dB bandwidth of 14% has been obtained. This transition has the potential to be used in millimeter-wave system applications.

REFERENCES


CONSTITUTIVE TENSORS OF OMEGA-AND CHIROFERRITES

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ABSTRACT: Using a group-theoretical approach, constitutive tensors for a new material composed of omega particles embedded in a ferrite are calculated and discussed. The analysis of the tensors is based on the decomposition of them into simpler forms. A comparison of these tensors with the known ones for chiroferrites is made. The constitutive tensors for some modifications of the chiro- and omegaferrites are calculated as well. © 2001 John Wiley & Sons, Inc. Microwave Opt Technol Lett 29: 201–205, 2001.

Key words: bianisotropic media; chiroferrite; omegaferrite; constitutive tensors; symmetry; group theory

1. INTRODUCTION

Recently, the constitutive tensors for an artificial material which is a combination of a ferrite and chiral particles (chiroferrite) have been obtained in [1, 8, 11]. Some experimental results on chiroferrites are discussed in [2]. Earlier [3, 4], media based on omega particles embedded in a dielectric host material were suggested. In this paper, we analyze a new combination formed by omega particles distributed in a ferrite [5]. Such a material can be called omegaferrite. We