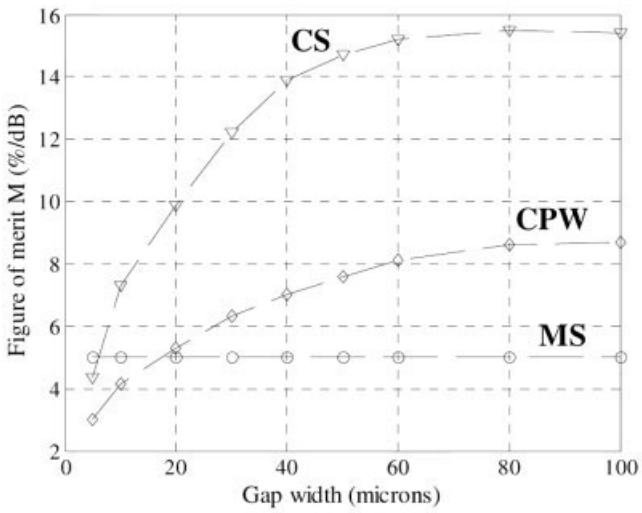

Figure 9 Variation of the figure of merit of TL at 10 GHz as a function of the gap width g. The figure of merit of MS lines has been included for comparison purposes. Conductors: $\sigma = 3.8 \times 10^7$ (Aluminium), $t = 2$ μm; Substrate: sapphire, $\varepsilon_r = 10$, tan $\delta = 10^{-4}$, $h = 500$ μm; Ferroelectric film: $\varepsilon_{rf} = 700$, tan $\delta_f = 5 \times 10^{-2}$, $h_f = 0.5$ μm. 5 μm $< g <$ 30 μm. - -⊖- - MS: $w = 436$ μm. - -◇- - CPW: $w = 18$ μm. - -▽- - CS: $w = 310$ μm

rable devices. We should also mention that a technological prerequisite for large integration and development of ferroelectric tunable components is to reach a loss tangent of the order of 10^{-2}.

REFERENCES

1. W. Kim, M.F. Iskander, and C. Tanaka, High performance low-cost phase-shifter design on ferroelectric materials technology, Electron Lett 40 (2004), 1345–1347.
2. H. Yoon, K.J. Vinoy, J.K. Abraham, and V.K. Varadan, CPW phase shifter using barium strontium titanate thin film on silicon substrate, In: IEEE antennas and propagation society international symposium, Colombus, Ohio, June 22–27, 2003, Vol. 3, pp. 970–972.
3. B. Acikel, T.R. Taylor, P.J. Hansen, J.S. Speck, and R.A. York, A new high performance phase shifter using $Ba_xSr_{1-x}TiO_3$ thin films, IEEE Microwave Wireless Compon Lett 12 (2002), 237–239.
4. P.T. Teo, K.A. Jose, Y.B. Gan, and V.K. Varadan, Beam scanning of array using ferroelectric phase shifters, Electron Lett 36 (2000), 1624–1626.
5. F.A. Miranda, G. Subramanyam, F.W. Van Keuls, R.R. Romanofsky, J.D. Warner, and C.H. Mueller, Design and development of ferroelectric tunable microwave components for Ku- and K-band satellite communications systems, IEEE Trans Microwave Theory Tech 48 (2000), 1181–1189.
6. K.-B. Kim, T.-S. Yun, H.-S. Kim, R.-Y. Kim, H.-G. Kim, and J.-C. Lee, An interdigital capacitor with high tunability and low loss tangent, In: 34th European microwave conference, Amsterdam, The Netherlands, October 11–15, 2004, pp. 161–164.
7. S. Gevorgian, S. Abadei, H. Berg, and H. Jacobson, MOS varactor with ferroelectric thin films, In: Microwave Symposium Digest, IEEE M TT-S international, Phoenix, Arizona, May 20–25, 2001, Vol. 2, pp. 1195–1198.
8. D. Kuylenstierna, G. Subramanyam, A. Vorobiev, and S. Gevorgian, Tunable electromagnetic performance of coplanar waveguides periodically loaded by ferroelectric varactors, Microwave Opt Technol Lett 39 (2003), 81–86.
9. D. Kuylenstierna, A. Vorobiev, P. Linnér, and S. Gevorgian, Composite right/left handed transmission line phase shifter using ferroelectric varactors, IEEE Microwave Wireless Compon Lett 16 (2006), 167–169.
10. A. Rousseau, M. Guilloux-Viry, V. Bouquet, A. Perrin, G. Tanné, F. Huret, J.F. Seaux, D. Cros, and V. Madrangeas, Ferroelectric thin films for applications in high frequency range, Ferroelectrics 316 (2005), 7–12.
11. K. Kageyama, A. Sakurai, A. Ando, and Y. Sakabe, Thickness effects on microwave properties of $(Ba,Sr)TiO_3$ films for frequency agile technologies, J Eur Ceram Soc 26 (2006), 1873–1877.
12. V. Laur, A. Rousseau, G. Tanné, P. Laurent, F. Huret, M. Guilloux-Viry, and B. Della, Tunable microwave components based on $KTa_{1-x}Nb_xO_3$ ferroelectric material, European Microwave Conference, Paris, France, October 3–7, 2005, Vol. 1, pp. 641–644.
13. H.-J. Bae, D.P. Norton, J. Sigman, and L. Boatner, Low dielectric losses in annealed Ti-doped $K(Ta,Nb)O_3$ thin films grown by pulsed laser deposition, J Phys D: Appl Phys 38 (2005), 1331–1336.

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EXTRACTION OF EFFECTIVE METAMATERIAL PARAMETERS BY PARAMETER FITTING OF DISPERSIVE MODELS

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ABSTRACT: *Effective electric permittivity and magnetic permeability for metamaterial structures are extracted from 3D field simulation data. The equivalent representation of the metamaterial is a homogeneous slab described with parameterized dispersive Drude and Lorentz models. The parameters of dispersive models are obtained by optimization. Proposed approach is applied to the extraction of effective material parameters for double negative metamaterial cells.* © 2006 Wiley Periodicals, Inc. Microwave Opt Technol Lett 49: 285–288, 2007; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.22105

Key words: *metamaterials; effective parameters*

1. INTRODUCTION

The occurrence of first works on negative electric permittivity and magnetic permeability structures [1, 2] gained enormous interest in the scientific community [3–5]. One of the concepts for the construction of a double negative (DNG) metamaterial (MTM) cell is to use a combination of a split ring resonator (SRR) and a wire, providing negative magnetic permeability and negative electric permittivity, respectively.

MTM structures are built of periodically ordered cells, with the assumption that the lattice constant is much less than the wavelength in the medium.

There are several methods for the extraction of effective material parameters for DNG MTM structures. The most popular approach is the extraction from transmission and reflection characteristics of a MTM, the method known from laboratory as a common way to find experimentally effective parameters of a material sample under test [6]. However, when applied to MTM cells, numerical problems occur, e.g. when transmission or reflection are very small in magnitude [7]. A variation of this approach is the extraction of effective impedance (z) and refractive index (n) of the MTM cell from scattering matrix, and next the computation of the effective permittivity ε_{eff} and permeability μ_{eff} from n, z values [8, 9]. Since the mentioned method happen to fail in some

cases, some improvements based on the determination of effective boundaries, forced continuity of the dispersive effective refractive index, and the elimination of the measurement/simulation noise influence on effective impedance of the DNG cell were proposed in Ref. 10.

The approach presented in this Letter is related to the extraction from scattering parameters. The main difference relies on the fact, that the shape of parameterized characteristics for effective permittivity and permeability is assumed a priori, and their parameters are optimized in order to obtain the best fitting to the reference responses.

2. PARAMETER FITTING OF DISPERSION MODELS

Within the presented method, effective material parameters are found by fitting scattering parameters of the equivalent representation to the scattering parameters of the reference structure. The reference structure is a detailed DNG geometry simulated in the electromagnetic solver, while the effective representation is a slab of a isotropic, homogeneous material described by dispersive Drude (electric permittivity) and Lorentz (magnetic permeability) models. The coefficients of the dispersive models are the parameters in the optimization process. The optimization goal is to minimize the difference between the scattering parameters obtained for the reference structure and the homogeneous structure. The homogeneous cell should provide the same transmission/reflection behaviour as the SRR/wire based DNG cell.

The simulation procedure for the DNG reference cell (structure from [2], dimensions given in Fig. 1), is similar to the one used in Ref. 11. An automeshing algorithm is used in CST Microwave studio [12] to create the computational grid for the SRR/wire geometry. Hundred mesh points per medium wavelength are chosen, resulting in ~38,400 mesh cells. The excitation pulse has a Gaussian distribution in time domain that is transformed into 1000 intermediate frequencies from 7 to 12 GHz in the frequency domain. The ports are at the $\pm x$ limits of the mesh volume where open boundary conditions are used. The structure is excited by the first mode of a waveguide port, with the electric field polarized in the y direction and propagating along the x direction. Magnetic boundary conditions are applied at the faces along the axis of the rings ($\pm z$ limits) and electric boundary conditions are used at the

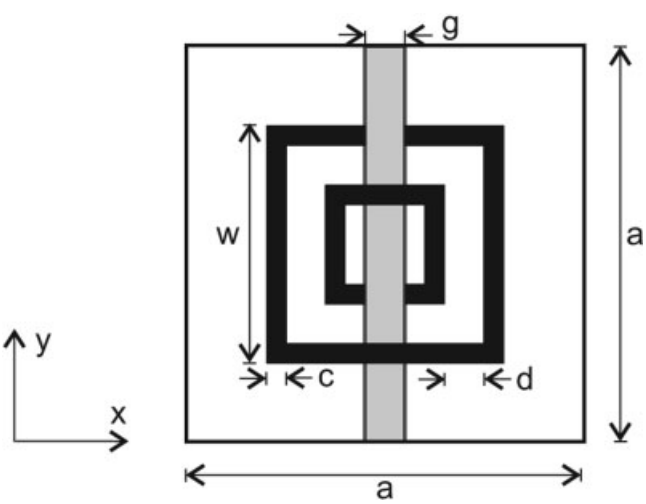

Figure 1 SRR/wire reference structure (SRR at the front side, wire at the back side of the PCB board), unit cell dimensions: gap width $g = 0.5$ mm, wire width $g = 0.5$ mm, lattice constant $a = 5$ mm, outer SRR height $w = 3$ mm, ring spacing $d = 0.5$ mm, strip width $c = 0.25$ mm

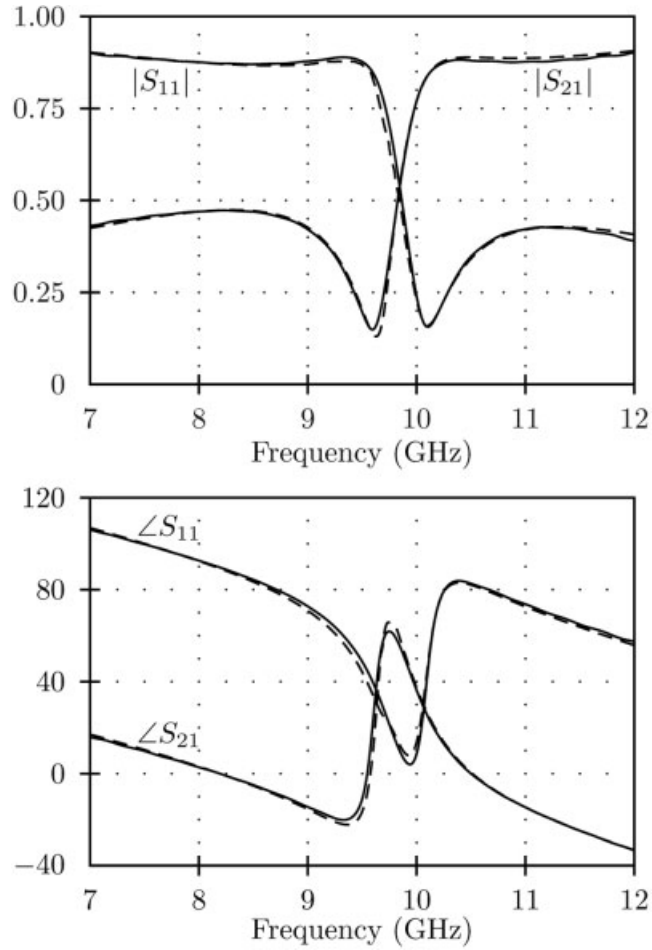

Figure 2 Magnitude (top) and angle (in [deg], bottom) of scattering parameters for SRR/wire reference structure (solid line) and for the optimized structure (dashed line)

$\pm y$ faces of the mesh volume. The ring and the wire are made of copper and placed on a 0.25 mm thick dielectric slab characterized by $\varepsilon_R = 3.84$ and $\tan \delta_\varepsilon = 0.018$. The numerical problem is solved by a time domain solver until the residual accuracy is -50 dB. Obtained scattering parameters $S11_{ref}$ and $S21_{ref}$ are presented in Figure 2.

The effective representation of the DNG MTM cell is a homogeneous slab with its thickness the same as for the MTM unit cell (5 mm for the structure from Fig. 1) and modelled as an isotropic medium with dielectric dispersion described by Drude model and magnetic dispersion characterized with Lorentz model. The Drude/Lorentz description of a DNG MTM is a common approach [13], where the Drude model of ε_{eff} represents an artificial medium composed of a lattice of wires [14], and the Lorentz model of μ_{eff} accounts for the effects in SRRs [1].

The scattering parameters for the homogenized DNG cell are obtained analytically. The effective permittivity and permeability models are assumed to be of the Drude and Lorentz form, respectively (the assumed time-dependence notation is $\exp(+jwt)$, the values of ε_{eff} and μ_{eff} are relative to those in free space):

$$\varepsilon_{eff}(\omega) = \varepsilon_\infty - \frac{\omega_p^2}{\omega(\omega - i\nu_c)} \tag{1}$$

where ε_∞ electric permittivity at the high frequency limit, ω_p radial plasma frequency, ν_c collision frequency;

TABLE 1 Optimized Drude/Lorentz Parameters for SRR/Wire Effective Structure

Parameter	Optimized Value
ε_∞	1.62
ω_p	$2 \cdot \pi \cdot 14.63$ GHz
ν_c	30.69 MHz
μ_s	1.26
μ^∞	1.12
ω_0	$2 \cdot \pi \cdot 9.67$ GHz
δ	1.24 GHz

$$\mu_{\text{eff}}(\omega) = \mu_\infty + \frac{(\mu_s - \mu_\infty)\omega_0^2}{\omega_0^2 + i\omega\delta - \omega^2} \tag{2}$$

where μ_s/μ_∞ magnetic permeability at the low/high frequency limit, ω_0 radial resonant frequency, δ damping frequency.

From the assumed material parameters effective impedance and refractive index are obtained (Z_0 is the impedance of free space):

$$Z_{\text{eff}} = Z_0 \sqrt{\frac{\mu_{\text{eff}}}{\varepsilon_{\text{eff}}}} \tag{3}$$

$$n_{\text{eff}} = \sqrt{\mu_{\text{eff}}\, \varepsilon_{\text{eff}}} \tag{4}$$

As the MTM structure is a passive medium, the signs in Eqs. (3) and (4) are determined by the requirement $\text{Re}(Z_{\text{eff}}) \geq 0$ and $n''_{\text{eff}} \geq 0$.

The reflection coefficient R at the boundary between free space and MTM slab of effective impedance Z_{eff}:

$$R = \frac{Z_{\text{eff}} - Z_0}{Z_{\text{eff}} + Z_0} \tag{5}$$

Transmission T through the homogenized slab of effective impedance Z_{eff}, refractive index n_{eff}, and thickness d gives:

$$T = \exp\left(-j\,\frac{\omega}{c}\, n_{\text{eff}}\, d\right) \tag{6}$$

where ω radial frequency and c velocity of light in free space. The dependence between reflection/transmission and scattering parameters [6]:

$$S11 = \frac{(1 - T^2)\,R}{1 - R^2T^2} \tag{7}$$

$$S21 = \frac{(1 - R^2)T}{1 - R^2T^2} \tag{8}$$

The Eqs. (1)–(8) relating scattering parameters with effective MTM permittivity and permeability are implemented in Matlab [15]. An optimization algorithm [16] searches for the values of ε_{eff} and μ_{eff} subparameters (namely: ε_∞, ω_p, ν_c, μ_s, μ_∞, ω_0, δ) providing the best fit between the scattering parameters of the homogenized (S11, S21) and the reference structure ($S11_{\text{ref}}$, $S21_{\text{ref}}$). The optimizer goal function takes the form:

$$G = \sum_i (|S11 - S11_{\text{ref}}|_{\omega i} + |S21 - S21_{\text{ref}}|_{\omega i}) \tag{9}$$

where scattering parameters are fitted at i frequencies in the frequency range of interest.

The optimized parameters of Drude and Lorentz models for the structure in Figure 1 are given in Table 1. A comparison of magnitude and angle of scattering parameters obtained by optimization with the reference results in Figure 2 shows a very good fitting. Corresponding ε_{eff} and μ_{eff} characteristics given in Figure 3 show a DNG behaviour in the frequency range 9.69–10.24 GHz. On the same figure effective permittivity and permeability extracted according to the method from [9] are presented. The obtained ε_{eff} and μ_{eff} values agree very well in the given frequency range. A small discrepancy for electric permittivity characteristic occurs at the frequency close to the resonant frequency of the magnetic permeability ω_0 (note the small negative value of ε'' which is a common problem of this method [9]).

3. DISCUSSION

The DNG MTM are generally anisotropic structures and their electromagnetic properties depend on the polarization of the applied field. The simple isotropic model presented in this article allows for the extraction of the diagonal components of permittivity and permeability tensors corresponding to the orientation of the

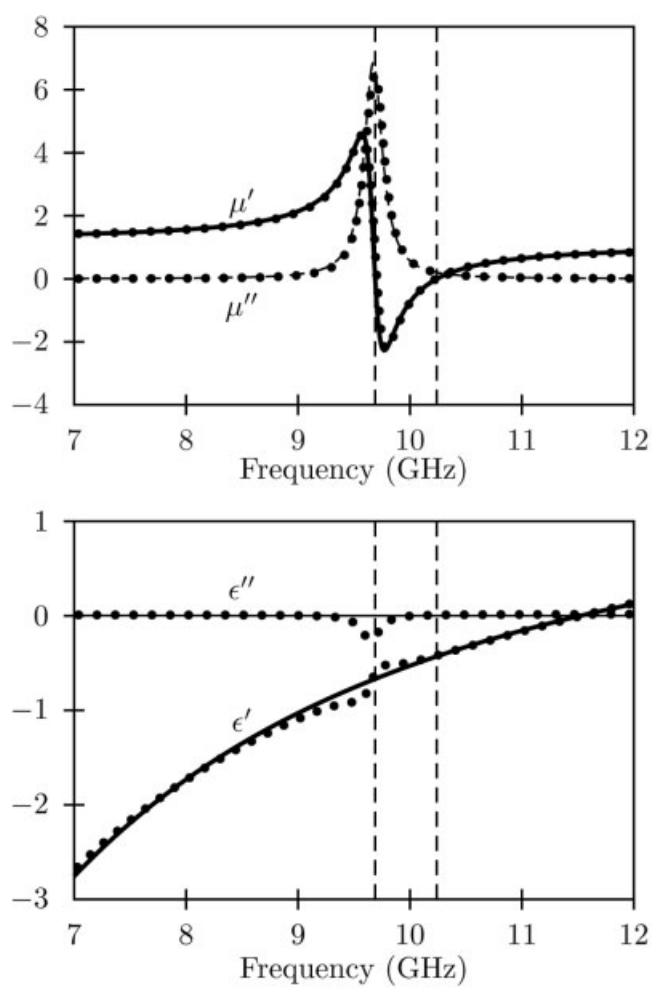

Figure 3 Effective magnetic permeability $\mu_{\text{eff}} = \mu' - j\mu''$ (top) and electric permittivity $\varepsilon_{\text{eff}} = \varepsilon' - j\varepsilon''$ (bottom) obtained by parameter fitting of dispersive models (μ', ε' solid thick line; μ'', ε'' solid thin line) and by direct extraction from scattering parameters according to the method from [9] (dotted line); the dashed vertical lines limit the DNG frequency band

excitation field. For many MTM structures, however, it is sufficient description.

The presented approach is limited to non and weak bianisotropic structures (for Ey and Hz field excitation, the SRR/wire configuration from Figure 1 is an example of such a structure [17]). The simple Drude/Lorentz model description does not take into account magnetoelectric couplings and for bianisotropic MTM more complicated methods of extraction should be used (e.g. [18]).

The a priori assumed Drude/Lorentz type shape of the effective parameters can be regarded as a limitation of the presented method. However, due to the strong resonant behaviour of DNG lattices, the extracted parameters of MTM structures are very often of such a shape [10, 11, 19]. On the other hand, there is no problem with the continuity of the fitted ε_{eff} and μ_{eff} characteristics. The imaginary parts of permittivity and permeability are positive ($\varepsilon'' > 0$ and $\mu'' > 0$), which is not always the case with traditional extraction from scattering parameters [9, 19, 20]. Some numerical ambiguities known for the extraction from scattering parameters (e.g. multiple branches of the logarithm function for the extraction of the real part of effective refraction index [8, 10]) are also avoided.

The method can be straightforwardly adopted to the fitting of effective description for single negative structures (e.g. MTM with negative magnetic permeability), as well as to arbitrary types of dispersive models. The delivered dispersive models can be directly implemented in commercial solvers [12] for higher order simulations of large structures composed of many MTM unit cells.

4. CONCLUSIONS

By optimization of parameterized Drude and Lorentz models the effective electric permittivity and magnetic permeability for SRR/wire structure have been found. The scattering parameters obtained for the equivalent representation agree very well with the reference results. The proposed approach helps to avoid some numerical problems occuring in the known extraction methods and can be applied to the extraction of effective material parameters for single and double negative metamaterials.

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REFERENCES

1. J.B. Pendry, A.J. Holden, D.J. Robbins, and W.J. Stewart, Magnetism from conductors and enhanced nonlinear phenomena, IEEE Trans Microwave Theory Tech 47 (1999), 2075–2084.
2. R.A. Shelby, D.R. Smith, and S. Schultz, Experimental verification of a negative index of refraction, Science 292 (2001), 77–79.
3. J.B. Pendry (editor), Focus issue on negative refraction and metamaterials, Optics Express 11 (2003), 639–760.
4. R.W. Ziolkowski and N. Engheta (editors), Special issue on metamaterials, IEEE Trans Antennas Propag 51 (2003), 2546–2750.
5. T. Itoh and A.A. Oliner (editors), Special issue on metamaterials, IEEE Trans Microwave Theory Tech 53 (2005), 1413–1556.
6. A.M. Nicolson and G.F. Ross, Measurement of the intrinsic properties of materials by time-domain techniques, IEEE Trans Instrum Meas 19 (1970), 377–382.
7. R.W. Ziolkowski, Design, fabrication and testing of double negative metamaterials, IEEE Trans Antennas Propag 51 (2003), 1516–1529.
8. D.R. Smith, S. Schultz, P. Markos, and C.M. Soukoulis, Determination of effective permittivity and permeability of metamaterials from reflection and transmission coefficients, Phys Rev B 65 (2002), 195104.
9. P. Markos and C.M. Soukoulis, Transmission properties and effective electromagnetic parameters of double negative metamaterials, Opt Express 11 (2003), 649–661.
10. X. Chen, T.M. Grzegorczyk, W. Bae-Ian, J. Pacheco, and J.A. Kong, Robust method to retrieve the constitutive effective parameters of metamaterials, Phys Rev E 70 (2004), 016608.
11. T. Weiland, R. Schuhmann, R.B. Greegor, C.G. Parazzoli, A.M. Vetter, D.R. Smith, D.C. Vier, and S. Schultz, Ab initio numerical simulation of left-handed metamaterials: Comparison of calculations and experiments, J Appl Phys 90 (2001), 5419–5424.
12. Computer Simulation Technology (CST), Available at http://www.cst.com.
13. J.B. Pendry and D.R. Smith, Reversing light with negative refraction, Phys Today 57 (2004), 37.
14. J.B. Pendry, A.J. Holden, W.J. Stewart, and I. Youngs, Extremely low frequency plasmons in metallic mesostructures, Phys Rev Lett 76 (1996), 4773–4776.
15. The MathWorks, Available at http://www.mathworks.com.
16. R. Storn and K. Price, Differential evolution—A simple and efficient heuristic for global optimization over continuous spaces, J Global Optim 11 (1997), 341–359.
17. R. Marques, F. Medina, and R. Rafii-El-Idrissi, Role of bianisotropy in negative permeability and left-handed metamaterials, Phys Rev B 65 (2002), 144440.
18. X. Chen, W. Bae-Ian, J.A. Kong, and T.M. Grzegorczyk, Retrieval of the effective constitutive parameters of bianisotropic materials, Phys Rev E 71 (2005), 046610.
19. B.-I. Wu, W. Wang, J. Pacheco, X. Chen, T. Grzegorczyk, and J.A. Kong, A study of using metamaterials as antenna substrate to enhance gain, Prog Electromagn Res PIERS 51 (2005), 295–328.
20. S. O'Brien and J.B. Pendry, Magnetic activity at infrared frequencies in structured metallic photonic crystals, J Phys: Condens Matter 14 (2002), 6383–6394.

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DESIGN OF LOWPASS FILTER USING A NOVEL SPLIT-RING RESONATOR DEFECTED GROUND STRUCTURE

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ABSTRACT: *A novel square split-ring resonator (SRR) defected ground structure (DGS) cell model is presented and analyzed in detail. Then an improved SRR DGS cell model loaded with open stubs is proposed in order to enhance the out-band suppression. Based on this structure, an S-band microstrip lowpass filter with low in-band loss and high out-band suppression is designed and fabricated effectively.* © 2006 Wiley Periodicals, Inc. Microwave Opt Technol Lett 49: 288–291, 2007; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.22111

Key words: *split-ring resonator (SRR); defected ground structure (DGS); lowpass filter*

1. INTRODUCTION

In the late 1990s, defected ground structure (DGS) was firstly proposed by Korean scholar J.I. Park et al. based on the idea of photonic band-gap structure, and has found its application in the design of planar circuits and lowpass filters [1–3]. DGS is realized by etching a defected pattern in the ground plane, which disturbs the shield current distribution in the ground plane. This disturbance can change the characteristics of a transmission line such as equivalent capacitance and inductance to obtain the slow-wave effect and band-stop property.

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