

# Surface and Leaky Modes of Multilayered Omega Structures

António L. Topa, Carlos R. Paiva, and Afonso M. Barbosa

Instituto de Telecomunicações, Instituto Superior Técnico  
Technical University of Lisbon  
Av. Rovisco Pais 1, 1049-001 Lisboa, Portugal  
Fax: +351-21-8417284; email: [antonio.topa@lx.it.pt](mailto:antonio.topa@lx.it.pt)

## Abstract

The omega or pseudochiral medium is an artificial complex medium [1], which can be fabricated by doping a host isotropic medium with  $\Omega$ -shaped planar conducting microstructures. An externally applied field induces both an electric and magnetic polarization, which are perpendicular to each other. The electromagnetic properties of these magnetoelectric media can be used in the design of reciprocal components for microwaves and millimeter-waves [2]-[4]. Depending on the spatial orientation, both TE and TM or hybrid modes may propagate. In a coupled orientation, each hybrid mode is a weighted combination of the two characteristic waves. For the spatial orientation considered in this paper only hybrid modes propagate.

In this paper we analyze the surface and leaky modes of open multilayered omega structures. The structures herein considered may consist of several different layers (pseudochiral or not) above an omega substrate. When the omega parameter exceeds a certain value, the surface hybrid modes may turn into leaky modes, which are improper complex solutions of the modal equation. Power leakage occurs, because one of the two characteristic waves ceases to be internally reflected at the substrate interface. Therefore, some of these modes may radiate energy into the substrate, provided that the constitutive parameters are properly chosen. These complex waves are usually termed semileaky waves [5], since one of the two characteristic waves still remains completely guided by the film layer.

A parametric analysis of the phase constant of the surface modes and leakage constant of semileaky modes with the constitutive parameters of each layer is presented.

## References

- [1] M. M. I. Saadoun and N. Engheta, "Pseudochiral  $\Omega$ -medium and guided-wave structures: Theory and principles," *Proc. URSI Int. Symp. Electromag. Theory*, Sydney, pp. 17-20, Aug. 1992.
- [2] M. M. I. Saadoun and N. Engheta, "A reciprocal phase shifter using novel pseudochiral or  $\Omega$ -medium," *Microwave Opt. Technol. Lett.*, Vol. 5, pp. 184-188, 1992.
- [3] J. Mazur and D. Pietrzak, "Field displacement phenomenon in a rectangular waveguide containing a thin plate of an  $\Omega$ -medium," *IEEE Microwave Guided Wave Lett.*, Vol. 6, pp. 34-36, Jan. 1996.
- [4] A. L. Topa, C. R. Paiva, and A. M. Barbosa, "Full-wave analysis of a nonradiative dielectric waveguide with a pseudochiral  $\Omega$ -slab," *IEEE Trans. Microwave Theory Tech.*, Vol. 46, pp. 1263-1269, 1998.
- [5] A. Knoesen, T. K. Gaylord, and M. G. Moharam, "Hybrid guided modes in uniaxial dielectric planar waveguides," *IEEE J. Lightwave Technol.*, Vol. 6, No. 6, pp. 1083-1104, June 1988.