

Abruptly terminated planar left-handed material waveguide

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Received: 20 November 2012 / Accepted: 23 February 2013 / Published online: 8 March 2013
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Abstract The problem of guided mode reflection from an abruptly terminated planar meta-material waveguide is studied by the variational technique. The theory is illustrated by examples of abruptly terminated three-layer waveguides with step permittivity and permeability profiles. Differences in the scattering characteristics for systems with metamaterials and usual media are discussed.

Keywords End of LHM waveguides · Surface modes

1 Introduction

The problems of the guided modes scattering from step irregularities of dielectric waveguides have a lot of applications. The irregularities of these types are abruptly ended waveguides, junctions of different waveguides, semiconductor laser facets, varied sensor elements, etc. Such problems have been treated in detail for the waveguides with the right-handed materials (RHMs); see, for example, the references in the papers by [Kendall et al. \(1993\)](#), [Tigelis and Manenkov \(1999\)](#). Recall that the RHMs are “usual” dielectrics, for which the permittivities ϵ and permeabilities μ are positive.

Now, new metamaterials are intensively studied and applied in various waveguide systems. Such materials are also called left-handed materials (LHMs) or media with negative refractive index. Their dielectric permittivity and magnetic permeability are simultaneously negative ([Smith et al. 2000](#); [Zhao et al. 2007](#)). As a rule, the metamaterials are artificial magneto-dielectrics (composites). They have unique electromagnetic properties (negative refraction of waves, reversed Cherenkov radiation, etc.). Presently the new LHMs with changing parameters are designed; their parameters can be governed by external actions (for example, external static fields). Note that applications of the metamaterials (with peculiar properties) can radically change the base principles of optical systems engineering.

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