

THE NONLINEAR SELF-DEFOCUSING ELECTROMAGNETIC SURFACE WAVES IN A METALISED FERRITE FILM

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Abstract

The dispersion relations for TE s-polarized nonlinear electromagnetic surface waves guided by a metallised ferrite film, surrounded by a nonlinear self-defocusing dielectric cover with intensity dependent refractive indices have been computed. Numerical results are also illustrated to show the propagation characteristics for different values of the film thickness, and at a fixed value of the dielectric-ferrite interface nonlinearity. It has been found that the surface waves exist in both directions of propagation, where the external field is applied. The propagation of these waves is non-reciprocal, and has a resonant interaction in the reverse direction. The power flow carried by the structure has also been calculated for different values of the slab thickness. The non-reciprocity has also been observed, and the power flow level can be controlled by the film thickness.

1. Introduction

The properties of nonlinear electromagnetic waves guided by gyrotropic structures¹⁻⁷ are subject of growing interests because of their proposed applications in Microwave Engineering Technology and Radar Communications System. Nonlinear magnetodynamic waves on magnetic materials for both TE (s-polarized) and TM (p-polarized) waves have been investigated theoretically^{2,5,6}. The magnetic permeability of nonlinear magnetic material is given by $\mu^{nl} = \mu_1 + \alpha |H|^2$. An exact theory has also been derived for TE waves that propagate along the single interface between a linear gyromagnetic substrate and a nonlinear dielectric medium whose refractive index depends upon the field intensity². The main feature of these waves is the different in the dispersion characteristics for the forward and the backward waves, which it means that the waves have non-reciprocal behaviour, and can lead to the non-reciprocity of the power flow variation with the wave index. The non-reciprocal characteristics can be applied in design some non-reciprocal devices as isolators and switches.

Recently Shabat⁷ has investigated the properties of the nonlinear surface waves in this structure for the case of nonlinear self-focusing dielectric cover.

This paper is going to investigate the properties of TE nonlinear electromagnetic waves in the metal - ferrite slab - nonlinear dielectric structure. Wave will be in a direction transverse to the applied magnetic field. The gyromagnetic slab has the permeability tensor, while the cover has the nonlinear dielectric function depends on the intensity of the light and can be written as $\epsilon^{nl} = \epsilon_1 + \alpha |E|^2$, where $\alpha > 0$ for self-focusing and $\alpha < 0$ for self-defocusing media. The existence conditions of nonlinear surface waves propagation have been examined. It has also