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NEW NONLINEAR MAGNETOSTATIC SURFACE WAVES IN A FERROMAGNETIC (YIG)

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Abstract

The general propagation characteristics of magnetostatic surface waves guided by a single interface of a semi-infinite nonlinear dielectric cover and a ferromagnetic substrate (YIG) have been derived. The nonlinear dielectric cover has intensity dependent refractive indices. The magnetostatic approximation is considered and retardation is ignored in describing the electromagnetic fields in the structure. The used magnetostatic approximation is leading to new waves and might be called nonlinear magnetostatic surface waves. The propagation of these waves is non-reciprocal in contrast to the linear magnetostaic surface waves, which had been only found in the negative direction of propagation.

1. Introduction

The magnetostatic surface waves which are defined by wavelength that are much smaller than practical sample dimension, had firstly been

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investigated by Damon And Esbach in a ferrite medium magnetized in the plane of its faces, and the surface waves propagate in a direction transverse to the applied static magnetic field in the frequency range $\sqrt{\omega_0(\omega_0+\omega_m)} < \omega < \omega_0 + \frac{\omega_m}{2}$, where ω_0 is the Larmor precession frequency and ω_m is the magnetization frequency[1-9]. The magnetostatic surface waves (MSSW) arise from Maxwell's equations, within a magnetostatic approximation, coupled to the Landau-Liftshiz equation for the magnetization in the limit $k \gg \frac{\omega}{c}\sqrt{\epsilon}$, where ω is the operating frequency, c is the light velocity in the vacuum, ϵ is the permittivity of the ferrite and k is the propagation constant of the wave (wave number) . Magnetostatic surface waves (MSSW) propagating in magnetic layered structures involving ferrimagnetic as yttrium iron garent (YIG) and other media can be applied to the development of microwave integrated electronics and microwave signal proceesing[1-9] The concept of these devices depends on the nonreciprocal propagation characteristics of magnetostatic surface waves (MSSW) offer lower propagation losses. The linear magnetostatic surface waves on a ferromagnetic half space and other magnetic structures have been investigated by several researchers in the voigt geometry [1-9] .

It seems that all the published papers describing the properties of nonlinear electromagnetic waves guided by gyromagnetic (ferrite) media have been derived[10-13] without using magnetostatic approximation and including retardation, for example an exact theory has also been derived for TE waves propagation along the single interface between a linear gyromagnetic substrate (YIG) and a nonlinear dielectric medium whose refractive index depends upon the field intensity[11] . The other papers describing the weakly nonlinear[15-18] magnetostatic surface waves on a YIG have recently been reported . In this paper, we consider the strong