LC-circuit

Metastructures ferrite plate/varactor loaded conductive resonant elements to achieving magnetic and fast electric control of microwave nonreciprocal transmission

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As is well known nonreciprocal effects at microwaves are based on ferromagnetic resonance (FMR) and Faraday Effect. At present there are ideas about artificial Faraday rotation in magnetless metamaterials without gyrotropic component [1] but strong losses complicate verification and real application.

In this paper we investigate experimentally and theoretically microwave nonreciprocal effects in planar metastructures ferrite plate/grating of resonant conductive elements (chains or single element). Effects are due to the FMR, influence of resonance in conductive elements (CER) and features of microwave magnetic field *h* near grating.

Metastructure shows unique nonreciprocal properties under coupled FMR and CER [2 - 4]:

— a more than hundredfold increase in the nonreciprocity δ of microwave transmission at FMR frequencies;

— appearance of δ (under formation of *h*-field of circular or elliptical polarization by a grating of resonant elements) whereas effect is absent when incident wave is linearly polarized in the case of free ferrite without grating of conductive elements;

— two nonreciprocal frequency bands of transmission controlled by a static magnetic field H_0 (the first band is due to the FMR and the second is due to CER and related to resonant elements).

In recent years the emphasis is novel functionality as magnetic and fast electric control of amplitude-frequency characteristics in contrast to traditional only magnetic control of ferrite by the field H_0.

We suggest planar meta-structures ferrite plate/varactor-loaded resonant elements [5-7] for development of fast controlled and switchable nonreciprocal microwave devices. The metastructures can provide:

— voltage controlled frequency bands of microwave nonreciprocal transmission by tuning varactor capacitance with changing reverse-bias voltages under the ferromagnetic resonance excitation near the varactor-loaded element resonance frequency;

— voltage controlled inversion of sign of δ without reversal of magnetization direction (one can change the sign of δ when the resonance frequency of the CER passes through the FMR frequency by application of a bias voltage to a varactor, as a result of which reversal of sense of rotation of elliptically polarized *h*-field occurs).

The proposed metastructures open up wide prospects for applications in the field of information and energy-saving technologies.

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