ELECTROMAGNETIC BAND GAP DEVICES CONTROLLED BY LOW PRESSURE DISCHARGE LAMPS

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Different electromagnetic band gap (EBG) structures have received growing attention in recent years. In the various EBG materials, most of them are realized by artificial metallic structures such as using wires to produce effective negative permittivity. However, most EBG materials proposed to date are based on immutable structure of the unit cell and result in a narrow band and not at all tunable. In order to fabricate a broadband and tunable EBG material some of its elements must be replaced by some other structures or materials. Glow discharge plasmas have high potentials as effective control elements in these devices. The flexibility of plasmas in the size, density and spatial arrangement can produce novel functional properties in the propagation of microwaves at the frequency range of our interest.

In present report we present our results on the propagation characteristics of electromagnetic waves through the both the waveguide band filters and EBG structures formed by metallic rods in combination with the plasma columns produced in low pressure discharge lamps. We discuss possibilities of the utilization of non-self-sustained atmospheric pressure glow discharges for EBG structure control.

In one series of our experiments, periodical structures were integrated inside the 90 x 10 mm² and 23 x 10 mm² waveguides. These structures consist of conductive rods (respectively 5 and 4 mm in diameter) distributed along the waveguides. Different configurations are tested where several of these rods are replaced by commercial 3 mm diameter neon discharge lamps (Γ III-5, produced in Russia). The electronic density in these lamps is estimated through the determination of the current density and the electron mobility and varies in the range of 0.3–2 10¹³ cm⁻³ when the current increases from 30 mA up to 130 mA. The transmittance attenuation up to 30/40 dB of both waveguide filters at several frequency bands is demonstrated using these gas discharge lamps. Measurements were produced by vector network analyzer Anritsu 37369C. There is a good agreement between experimental data and simulated ones by Ansoft-HFSS commercial software.

Another series of experiments were carried out with a similar space triangular EBG structures in [1, 2] formed by a square network of metallic rods. The EBG structure dimensions are modified from the one in [1] in order to have identical properties in the range of 8 GHz. The rods (with diameter, d = 3 mm) are distributed in a square lattice with a step size, a = 22 mm. One of this EBG's interesting properties is, at the working frequency in the ranges of 8 GHz, the longitudinal direction is totally forbidden while the diagonal direction is allowed. In order to excite the diagonal mode, we introduce defaults by removing two rods at the EBG interface. We registered a signal of diagonal mode at direction of 45° to the longitudinal one in this case. At the replacement each of these two rods by a plasma column of gas discharge lamps leads to a decrease of diagonal mode signal on about 10 dB at discharge current of 120 mA.

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References

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