2D electromagnetic band gap structure controlled by plasma

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During the last decade, there has been a substantial increase in attention paid to the plasma control of the electromagnetic band gap (EBG) structures [1] operating in microwave region. However, most of the modern devices, which utilize EBG structures effect, are built using metallic elements, and as a result, have fixed parameters and do not allow fast reconfiguration and adjustment. At the same time, glow discharge plasma has a great potential for the application in microwave devices serving as control elements. In the previous research, 1D EBG structure formed solely by plasma column in waveguide was reported in [2]. The possibility to control the microwave propagation by plasma columns through a triangle 2D EBG structure was experimentally demonstrated in [3]. In this report, plasma control of microwave propagation through a triangle 2D EBG at high power is addressed.

The triangle periodical structure is formed by copper rods of 5 mm in diameter, which are distributed uniformly with a lattice constant of 22 mm. When this EBG structure is perfect, the propagation of wave at frequency 9.15 GHz is forbidden in all directions. However, the propagation for this frequency becomes possible in the directions of around ±45° when localized defects are introduced at the interface of the EBG structure. In order to introduce a defect or to compensate an existing one, we use long scale positive columns of low pressure commercial discharge lamps GSh-5. The control of diagonal mode amplitude by electron density variation is demonstrated.

The 2D EBG structure was tested at high microwave power (about 40 kW, pulse duration is 150 ns). It is important to differentiate as two separate cases if the power of microwaves passing through the structure is larger or not than the power for microwave discharge breakdown in lamp tube. In the case of defect compensation, MW radiation for the frequency outside of EBG pass band passes through triangle structure only during the time prior to discharge creation under the effect of radiation. Pulse duration of MW radiation at the EBG structure output is defined by the rise time of electron concentration in tubes. It allows to obtain the diagonal mode switch on in 30 ns and less. For the case of inverse relation between incident and breakdown powers, the discharge in tube should be ignited by external voltage sources. Through varying the delay time between the rise time of incident MW pulse and the time of discharge ignition, it is possible to change the output pulse duration in the range from microseconds up to nanoseconds scales.