Observation of controllable non-Bragg gap in periodically corrugated waveguide

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We investigated the microwave transmission spectrum in a rectangular metallic waveguide, having lower and upper walls with the identical sinusoidal profile and two smooth side walls. The upper periodically corrugated plate was made movable. It could easily slide with respect to the stationary lower plate forming the phase shift between the periodic walls.

Bragg reflection is a fundamental wave phenomenon arising upon wave propagation in a periodic medium. It results in the opening of the Bragg gap in the transmission spectrum of the signal. The gap arises at $k = q/2$, known as Bragg's law, where $q = 2\pi/a$, a is a period of the structure, k is the wave number.

In this report, we present the results of theoretical analysis and experimental investigation of the non-Bragg gap which also opens in the transmission spectrum. The non-Bragg gap is caused by the resonant interaction between the transverse modes. The Bragg gaps open only at $k = q/2 \equiv K$, or multiple of K, the values corresponding to the Brillouin zone boundaries. While the non-Bragg gap can open at any value of k between zero and K. This tuning can be done by shifting one periodic plate with respect to another. Besides the controlling the position of the gap in the spectrum, the width of the non-Bragg gap can be also changed between zero and a maximum value (1.2 GHz in our experiment) upon the shift on the half period of the corrugation $a/2$. It has been found that in a case of the congruent boundaries, all Bragg gaps are closed, and only non-Bragg gaps are present in the transmission spectrum.

We observed the controllable non-Bragg gap at 7.7 GHz in the same periodic waveguide geometry that we used for investigation of the controllable Bragg gap (V.A. Pogrebnyak, J. J. Whalen, URSI 2006 Book of Abstracts, Boulder, Colorado, 34, 2006; Electronics Letters, 43, 226-228, 2007). The conducted experiment showed that a $a/2$ shift of the periodic plate caused the closing of two Bragg gaps at 6 and 10 GHz and opening of a controllable non-Bragg gap at 7.7 GHz. The width of the non-Bragg gap could be changed between zero and 1.2 GHz upon such shift of the plate.

The proposed above structure could be used to control power transmission in different microwave, photonic and integrated optics devices.