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Wideband Waveguide Loading Impedance Matching on the Basis of Photonic Crystals with Nanometer Metal Layers[1]

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Abstract—Theoretically shown and experimentally proven is the possibility of creating wideband matched loading on the basis of photonic crystals, composed of alternating nanometer metal and isolator layers with different electro-physical parameters.

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The problem of designing wideband matched loadings is considered to be one of the vital problems of microwave radio electronics. Microwave loadings are widely used independently and as elements of complex functional devices: directional couplers, power combiners and measurers, measuring bridges, filters, etc. [1, 2].

Waveguide loadings are divided into surface and volume. Volume loadings are widely used. Constructively they are composed of a waveguide segment, short circuit at one end and equipped with a connection flange at the other one. Tapered segment of isolator material, filled with powder iron with length comparable or greater than the wavelength of electromagnetic radiation, is placed inside the waveguide.

Surface loadings, as a rule, represent electricity conducting coating layered on isolator base. Various substances may be used as a material for coating, for instance, plastic being polyethylene with added in some proportion co-polymer and soot, possessing conductivity. Absorber may also represent a mixture of ferrite powder and organic high-polymeric substance.

One of the main problems solved during the design of matched loadings used for low and middle power microwave radiation is providing impedance matching in a maximally wide frequencies range with minimal structure's dimensions.

Intensive development of nanotechnologies stimulated the design and creation of a new class of periodic structures which obtained the name of photonic crystals [3]. These structures are composed of periodically alternating layers, which dimensions are of comparable size with the wavelength of the electromagnetic radiation propagating in them. In the passing band of such structure there are regions permitted and forbidden for electromagnetic wave propagation which are analogs of permitted and forbidden zones in crystals.

In the microwave band single-dimensional photonic crystal may be realized either as planar transmission lines [4–6] or as waveguides with changing isolator filling [7, 8]. Band-pass filters, tunable resonators and miniature antennas are created on the basis of microwave photonic crystals [7, 9–11].

Frequency dependencies of the reflection coefficients for microwave electromagnetic radiation reflected from photonic crystals, containing nanometer metal layers, were studied in papers [8, 12]. It was shown that the reflection coefficient in such systems may vary in extremely wide ranges in cases of insignificant changes of metal film thickness which does not exceed several tens of nanometers.

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