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Structural design of metallic waveguide device in the microwave range using topological design process

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ABSTRACT

In this study, we propose unprecedented metallic waveguide design using topological design schemes in the microwave range. Two types of topological design scheme, the ON/OFF method and topology optimization based on the phase field method, are used to suggest exetraordinary metallic waveguide devices. The ON/OFF method has been usefully applied to various applications. It is easy to calculate the design sensitivity and to select the flexible optimization process as a one of topological design approaches [1]. Recently, topology optimization based on the phase field method has been known as one of new and effective shape optimization methods. It guarantees to avoid the checkerboard pattens and gray scale problem occurred in the SIMP method [2]. It is analogous to topology optimization in terms of the usage of phase field parameter ϕ instead of primal design variable density ρ in the SIMP method. Also, numerical analysis and methodological approach are similar to topology optimization except the updating scheme of design variable and the region used for sensitivity calculations.

For the device design, perfect electrically conducting (PEC) material is used to consruct a waveguide structure. The material property of metal is highly significant that it has an influence on the phase field parameter ϕ. The objective function is composed of a specific equation with respect to scattering parameter depending on the frequency and it is set to maximize transmitted power from input port to output port according to a designated frequency for the purpose of working as a waveguide bandpass filter. Thus, shapes of the metallic waveguides consisting of variable metallic filters in a specific radio frequency range are represented in this research. The optimization process was performed by Matleb 7.0a programming as inter-working with commercial package COMSOL multiphysics 3.5a for finite element analysis.

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