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Structural optimization for cloaking effect using dielectric material based on the phase field method

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Abstract

A cloaking device can manipulate the electromagnetic wave having a specific range of frequency so that it can hide the objects inside the cloaking region from an external observer. This research suggests a cloaking structure using the structural topology optimization based on the phase field method. Double well potential function was combined with the method in order to obtain a boundary tracking scheme. The optimal configuration composed of air and dielectric material was determined for minimizing the norm value of the scattered field from the cloaking structure through the optimization process. Therefore, electric permittivity was used for the material property. The target frequency was set to 10GHz (microwave X-band) and the transverse electric polarization was considered. Effects of some parameters related to the phase field method such as volume constraint, initial design and time step were also investigated to get an optimal design. In addition, The sensitivity analysis was modified for realizing rotational symmetry. Finally, the optimal results are presented via several numerical examples based on the selection of above design factors. The optimal results have 6 and 8 rotational symmetric region and they show good performance for cloaking effect. The finite element method was performed by the commercial package COMSOL with Matlab programming.

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