Abstracts

Optimized irregular structures for spatial- and temporal-field transformation

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In a bounded region such as a waveguide, a mode is an eigensolution of the electromagnetic-wave equation with particular boundary conditions imposed. Conversion from one mode to another through a mode converter could be accomplished by using a scatterer located within the waveguide. Generalizing to an arbitrary domain, either within a waveguide or in unbounded media, a field transformer converts one spatial field to another as a function of frequency. Mode-control elements usually employ periodic structures and a special case of this mode conversion is filtering (amplitude and phase control) with the same input and output mode. We have developed a new kind of field transformer which uses aperiodic structures. Specific designs are arrived at through numerical optimization of a cost function representing the mode transformation. Rather than effecting field transformations using a series of small geometry perturbations, our concept forcefully changes the field using an optimized structure. The optimization process allows consideration of a number of electrical and mechanical issues, such as efficiency, bandwidth, size, and amenability to manufacture. We present designs for microwave mode converters using our optimized irregular structure concept and compare them with those achieved using a periodic coupled-mode concept. These designs show dramatic improvements in performance and physical size, while incorporating a dimensional constraint and sensitivity analysis that provides for ease in fabrication.

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