DISSIPATION IN COMPOSITES WITH HIGH-LOSS AND LOSSLESS COMPONENTS

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Use of low-loss magnetic materials in high-power microwave devices can improve significantly their performance. We have demonstrated that the electromagnetic losses in the composite structure can be reduced by up to two orders of magnitude, compared to those of the uniform magnetic sample made of the same lossy magnetic material. Importantly, the dramatic absorption reduction is not a resonance effect and occurs over a broad frequency range covering a significant portion of the respective photonic frequency band. The optimal configuration of the composite may depend on the dominant physical mechanism of absorption, such as electric conductivity or domain wall friction.

We developed a general theory of composite structures involving high- and low-loss components. Guiding examples for our studies come from two-component dielectric media composed of a high-loss and lossless components. The question stands: is it possible to design a composite material/system which would have a desired property comparable with a naturally occurring bulk substance but with significantly reduced losses. In a search of such a lowloss composite it is appropriate to assume that the lossy component, for instance magnetic, constitutes the significant fraction which carries the desired property. But then it is far from clear whether a significant loss reduction is achievable at all. It is quite remarkable that the answer to the above question is affirmative, and we produced an example of a simple layered structure having magnetic properties comparable with a natural bulk material but with 100 times lesser losses in wide frequency range is constructed. A principal result of our theoretical studies is that a two component system involving a high-loss component can be significantly low loss in a wide frequency range provided, to some surprise, that the lossy component is sufficiently lossy. An explanation for this phenomenon is that if the lossy part of the system has losses exceeding a critical value it goes into essentially an overdamping regime, that is a regime with no oscillatory motion.


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