Property and Performance Prediction of Meta Composites for Novel Applications

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Abstract

Metacomposites are new class of materials with unusual properties that can be engineered using existing materials with usual properties. The unusual properties of metacomposites are derived from the structure, analogues to atomic arrangement in crystal lattice. These material exhibits unusual negative refraction type behavior to electromagnetic wave propagation and thus enables novel applications. The focus of this paper is on the modeling methods for predicting the effective properties and performance of metacomposites for novel application development.
Numerical models in COMSOL Multiphysics were developed to investigate the macro behavior using homogenized and heterogeneous microstructure based models. Computer aided Micro Mechanical models leverage the actual micro structure to predict the macro performance. The homogenized model uses the effective properties for macro performance evaluation of metacomposites. Available analytical models are also used to predict and compare the effective properties. The above modeling method provides many benefits for metacomposites performance evaluation at the cost of complexity, time and resources. The details of the model development, the simulation method and results will be reported with a focus on the application development. The wave propagation results predicted with micromechanical and homogenized models are shown in figure 1 and 2, respectively. Comparison of Figure 1 and 2 shows the effectiveness of modeling method in performance prediction. Figure 3 shows the micromechanical models results on the elastic resonance of metacomposites. Further, A Multi-level modeling approach is also suggested for novel metacomposites application development by combining micromechanics and effective property prediction simulation methods. The performance prediction method and its applications related to flat lens, clocking, engineered wave propagation, high impedance surfaces, antenna miniaturization and super lens will also be highlighted.

Figures used in the abstract

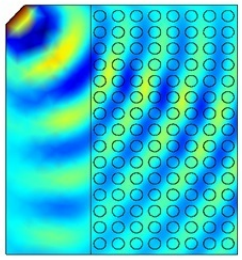

Figure .1 Wave Propagation through the composite medium with microstructure medium

Figure 1: Contour plots of wave propagation through the composite medium with heterogeneous microstructure.

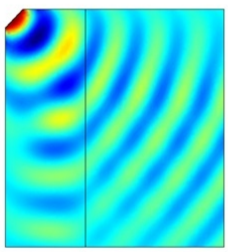

Figure 2 Wave Propagation through metacomposites with homogeniously medium

Figure 2: Contour plots of wave propagation through the metacomposites with homogenioused medium.

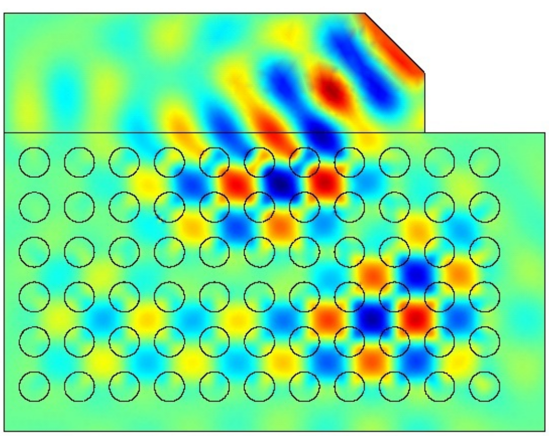

Figure 3: Typical Electrostatic Resonance effects of metacomposites.