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Multilayer Absorber Based on Carbon Fibers Loaded Epoxy Foam

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Due to the rapid development of electronics and telecommunications, protection against electromagnetic waves has become an active area of research, and the intensification of protective materials usage is reflecting the market needs and the great demand of such products. The form and composition of electromagnetic absorbers are various and depend on the application under consideration. The typical absorbing materials used in the anechoic chambers are made of Polyurethane (PU) foam loaded with carbon particles. These absorbers have either flat or pyramidal forms [1]; our targeted form is the flat multilayer absorber. The foam structure of these absorbers gives them a low density but also a high flexibility which induces machining errors. On the other hand, the carbon particles load ensures an absorption in large frequency band but this load is volatile as well so that it can easily escapes from the absorber and threatens human health. Our proposed material [2] is made of epoxy foam (rigid foam) loaded with carbon fibers (nonvolatile load).

The design idea behind an absorber is to simultaneously minimize the wave transmission and reflection, as well as to maximize its absorption rate. For a multilayer absorber, the composition and the thickness of each layer would be adapted in order to achieve broadband behavior with high absorption performance. In this study, the multilayer absorber is made of four layers with a total thickness of 250 mm or 125 mm. Different composites are used with different carbon fiber lengths (3 mm, 6 mm, and 12 mm) and weight percentages of fiber load (from 0.25 wt.% to 1 wt.%). The first layer of the proposed planar absorber, in front of the incident wave, is the unloaded epoxy foam with low dielectric properties (ε_r = 1.2 and tanδ = 0.009) in order to reduce the impedance mismatch between air and the absorber. For the other layers, the impedances of composites are calculated (Figure 1) using the measured dielectric properties of each material, and the order of layers is then chosen based on the principle of impedance gradient [3]. Simulation of the multilayer absorbers within the frequency band ranging between 2 and 18 GHz has been made using CST software studio. After that, Genetic Algorithm has been used in order to optimize the thickness of each layer. Simulations and measurements of the achieved prototypes will be presented, discussed and compared to a commercial material with the same thicknesses.

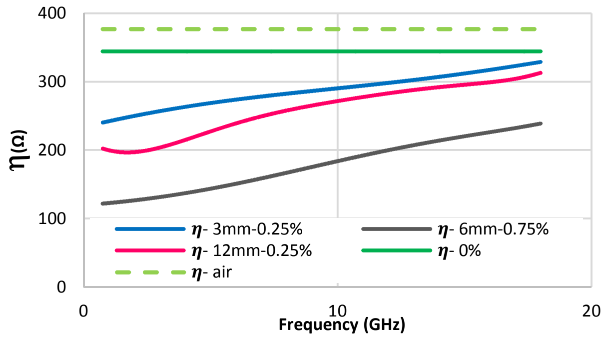

Figure 1. Calculated values of caracteristic impedance of the selected composites

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