

Carbon Based Nanomaterial Composites in RAM and Microwave Shielding Applications

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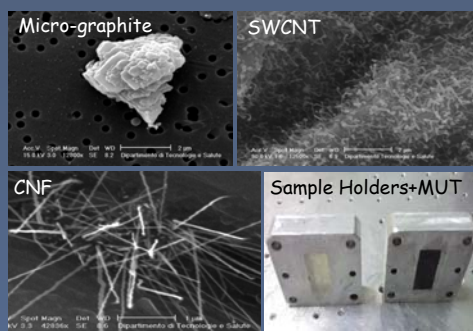
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This work deals with the design of electromagnetic absorber of interest in radar absorbing material (RAM) and microwave shielding systems. This absorber is based on a multilayer structure and the parameters taken into account during design stage are: number of layers, absorption maximization, microwave angle of incidence and frequency band. Design and optimization of the absorber are carried out using a Genetic Algorithm (GA) based on actual electrical parameters. Such stochastic method leads to the best trade off between absorption properties and structure thickness, minimizing both the reflection coefficient and the global multilayer thickness. All the (carbon based) dielectric materials adopted in GA have been characterized as a function of frequency and, their characteristic impedances have been recorded in a data base to be available during design stage. In particular, employed materials consist of epoxy resin reinforced with three different carbon species: micro sized granular graphite, single walled carbon nanotubes (SWCNT) and carbon nanofibers (CNF). The morphology of the multilayer structures is fixed a priori, - i.e., composite material type and its location in the multilayer structure is given - and the stochastic optimization procedure can only decide the best thickness of each layer. Main goals have been achieved and the possibility of realizing a quasi-perfect microwave absorber through graphite and nanomaterials has been demonstrated.

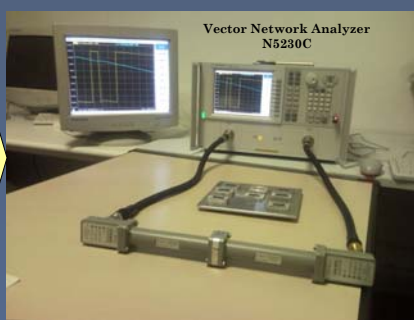
MATERIALS AND MICROWAVE MEASUREMENT METHODS



SEM images of the different carbon species

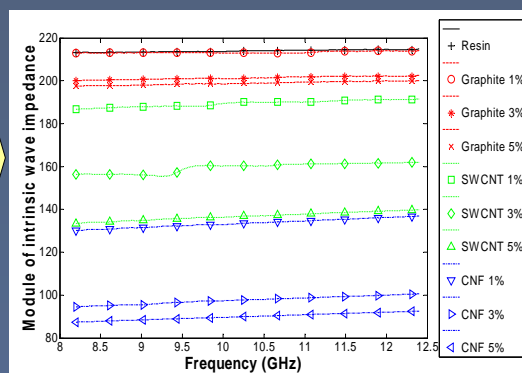
Carbon Material	Dimension	Bulk Density (g/cm ³)	Specific Surface Area (m ² /g)	Purity (wt%)
Graphite	granulometry < 20µm	~ 0.8	6.5-10.5	>99%
SWCNT	diameter 1-2nm (rope diameter 20nm) length 2-5µm	0.14	~ 400	70%
CNF	inner diameter 0.5-10nm outer diameter 80-200nm length 0.5-20µm	0.06-0.08	~ 60	> 95%

Carbon species employed



The microwave characterization has been carried out performing scattering measurements and extracting the electrical permittivity through canonical algorithms. We adopted and compared Nicholson-Ross and New Non Iterative algorithms.

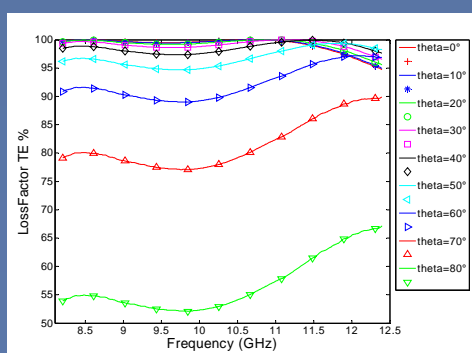
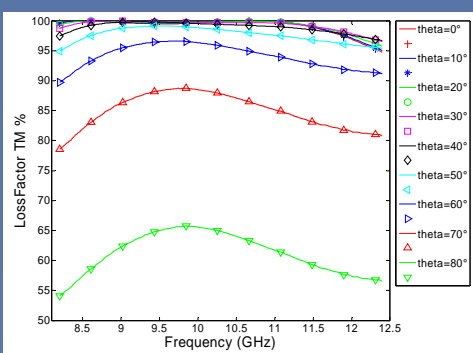
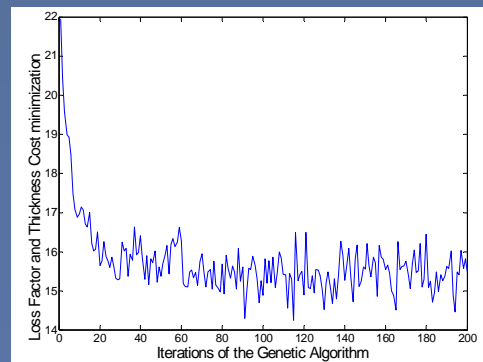
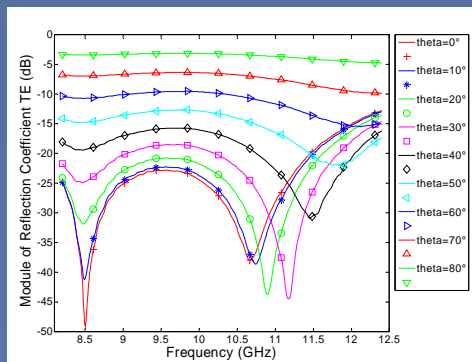
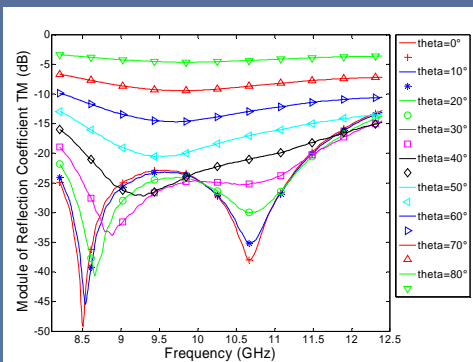
Measurements setup consists of a vector network analyzer (VNA) Agilent PNA L working up to 20 GHz, wave guide calibration kit in the X-band (8.2-12.4 GHz), sample holder hosting the material under test (MUT) of 9.77 mm thickness. Permittivity results give wave impedance values.



MULTILAYER STRUCTURE DESIGN

Thickness (mm)	0	2	1	1	0	0	0	0	3	3
AIR										
		1% wt GRAPHITE	3% wt GRAPHITE	5% wt GRAPHITE						
									3% wt CNF	5% wt CNF
										PEC

GENETIC ALGORITHM RESULTS



CONCLUSION

Presented RAM design method shows that interesting results can be obtained using multilayer structure based on carbon composite nano-materials and micro-graphite. In particular, the use of nano-filler like CNFs, pushes absorption performances over the more conventional graphite absorber, which generally requires for higher thicknesses to obtain similar absorption properties. With the aid of GA optimization, we demonstrated the possibility of achieving quasi-perfect microwave absorption through the joint application of traditional graphite and carbon nano-materials