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NANOSTRUCTURED COMPOSITE MATERIALS FOR ELECTROMAGNETIC INTERFERENCE SHIELDING APPLICATIONS

Abstract

Currently some aerospace applications of composite materials is to substitute classical metal-based structural element with composite-based element and most current work deals with the importance of EMI shielding systems. This is particularly important as an example on board the satellite/space vehicle, where several electronic subsystems have to operate with different interference sensitivity close to each other, e.g. telecommunication and telemetry subsystems, DC supplier subsystems, acquisition data subsystem, navigation subsystem, attitude control subsystem etc. In this paper we propose an advanced concept of composite structure which is simultaneously microwave shielding and microwave absorbing capable. The proposed structures are based on multilayered systems made of nanostrucutred composite materials built by using epoxy resin and carbon nanopowders as carbon nanotube, carbon nanofiber, fullerene, and micrographite. Such materials have been first characterized in terms of electric permittivity in previous works and here are assumed to form a database in order to be properly chosen by optimization algorithms. The design of such multilayered structure is not trivial since they must respect structural mechanics and electrical properties: in this work we focused our research in optimizing microwave absorbing properties only. In particular, the design algorithms have multiple tasks since they must determine an optimized multilayer structure based on carbon composite nanostructured materials; these latter are available in the data base as a trade off between overall thickness and microwave reflection and transmission coefficient to be minimized as much as possible. The algorithm proposed here for the design of structure is a new evolutionary algorithm in-house built and baptized by us as winning particle optimization. It is a very simple algorithm where at each time epoch of evolution, particle which best fits the objective function is deputed to pilot the trajectory of the remaining particles within the multidimensional space of solutions. Winning particle optimization is easy to implement and run, in fact each single particle acts with no any knowledge about other particles with exception of the best fitting particle index: under this point of view winning particle optimization it's like a primordial non intelligent life form, which tries to find the best place to grow and proliferate. Step by step this simple but quite effective method evolves toward the best solution; the iterations are stopped when all particles end to converge in a single point which represents the optimal solution.

Index Terms — X-band, RAM, EMI Shielding, Particle Swarm Optimization, Evolutionary Algorithm, Winning Particle Optimization.