Low-high frequency inspection of composite multi-layers and MUSIC-type electromagnetic imaging

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Abstract

Non Destructive Testing-Evaluation (NdT-E) of complex multi-layer composite panels for problems of quality, viability, safety and availability of complex systems involving manufactured parts (in aeronautics and in automotive industry, as a good example) is becoming an interesting and challenging task nowadays.

From eddy-currents to microwaves, there is the need to make available modeling and imaging procedures that will be robust, fast, accurate and useful to potential end-users: this requires a sound description of the panels. At a first level of modeling, these aforementioned panels can be considered as a succession of planar slabs which are laying one over the other; each slab is usually formed by a bundle of fibers, whose orientation is parallel with the interfaces and usually it is differing from one to the next. Those fibers may exhibit either electromagnetic isotropy or anisotropy: in the isotropic case, the material parameters are described by scalar space-dependent (and frequency-dependent in most cases) quantities while the anisotropic case leads to tensor quantities. From a modeling perspective at an enough large scale (compared to the local wavelength in propagative case or to the skin depth in diffusive case), the assumption leads to consider a given slab as homogeneous, i.e., its electromagnetic parameters tensor is locally averaged. Based on [1-2], it is proposed herein a method to compute in an effective fashion the dyadic Green's functions (DGF) for such structures within the framework of contrast-source integral equations.

Damages or disorders, which those composite may suffer from, are of many kinds: voids, fluid-filled cavities, delaminations, etc., with obvious consequences on their electromagnetic and geometric parameters. That is, the task of making available to end-users some images of the possibly damaged parts. The MUSIC-type (MUltiple SIgnal Classification) algorithm [3] is a good candidate to find the position of small defects.

References

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