Fast Calculation of Response of Scatterers in Uniaxial Laminates

Yu Zhong, Xudong Chen, Ping-Ping Ding, Marc Lambert, Dominique Lesselier

Fast Calculation of Response of Scatterers in Uniaxial Laminates

Yu Zhong[1], **Xudong Chen**[2], **Pingping Ding**[3], **Marc Lambert**[3], **and Dominique Lesselier**[3]

[1]A*STAR, Institution of High Performance Computing, 138632, Singapore
[2]Department of Electrical and Computer Engineering
National University of Singapore, 117576, Singapore
[3]Laboratoire des Signaux et Systèmes, Départment de Recherche en Electromagnétisme
UMR8506 (CNRS, Supélec, University Paris-Sud)
3, rue Joliot-Curie, Gif-sur-Yvette cedex 91192, France

Abstract— The volume integral equation method, usually implemented via the method of moments (MoM), is a popular approach to many scattering problems, like when inhomogeneous bodies are embedded within planarly layered media and made to interact with given sources, as henceforth considered.

When the layered media are isotropic, the construction of the impedance matrix of the MoM, the bottleneck of the method, can be fast since one is able to accelerate the calculation of the 1-D Sommerfeld integrals [1]. This is due to the fact that the dispersion relations of the isotropic media enable to calculate the integral along the azimuth direction in closed form.

But, if the uniaxial media are with optical axes parallel with the interfaces, e.g., [2, 3], or if the media are biaxially anisotropic, the above fast methods do not apply anymore. This results in possibly high computational cost to ensure accuracy when dealing with the 2-D inverse Fourier transform (IFT). However, we might still circumvent it, with the rectilinear mesh as done in traditional practice in volume integral equation methods, achieving efficient construction of the impedance matrix.

In a pioneering contribution [4], a method that uses the continuous Fourier transform and a windowing technique is proposed to analyse metal patches within an isotropic multi-layered structure, which can be used to avoid the conventional 2-D IFT. By the generalized Poisson summation formula and the windowing technique, the relation between the discrete Fourier spectrum and the continuous Fourier spectrum of the spatial response is re-derived, which, by using it, enables to efficiently and accurately calculate the response of the multilayer on a rectilinear mesh.

When the continuous Fourier spectrum of the response of the laminates to the current basis function is available, which can be stably and efficiently calculated by the new recurrence relations proposed in our previous contribution [5], we use such a fast method to construct the impedance matrix of the MoM involving uniaxial layered media whose optical axes lie parallel to their planar interfaces. Numerical tests confirm the efficacy of the proposed method.

REFERENCES

1. Alparslan, A., M. I. Aksun, and K. A. Michalski, "Closed-form Green's functions in planar layered media for all ranges and materials," *IEEE Trans. Microwave Theory Tech.*, Vol. 58, 602–613, 2010.
2. Burke, S., "Eddy-current induction in a uniaxially anisotropic plate," *J. Appl. Phys.*, Vol. 68, 3080–3090, 1990.
3. Wasselynck, G., D. Trichet, B. Ramdane, and J. Fouladagar, "Microscopic and macroscopic electromagnetic and thermal modeling of carbon fiber reinforced polymer composites," *IEEE Trans. Magn.*, Vol. 47, 1114–1117, 2011.
4. Catedra, M. and E. Gago, "Spectral domain analysis of conducting patches of arbitrary geometry in multilayer media using the CG-FFT method," *IEEE Trans. Antennas Propagat.*, Vol. 38, 1530–1536, 1990.
5. Zhong, Y., M. Lambert, D. Lesselier, and X. Chen, "Electromagnetic response of anisotropic laminates to distributed sources," *IEEE Trans. Antennas Propagat.*, Vol. 62, 247–256, 2014.