Efficient Modeling of Thin Sheet in Multilayered Uniaxial Media

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Scattering of electromagnetic waves by arbitrary objects in multilayered media has attracted large attention of researchers due to its wide applications, such as the geophysical exploration and printed microwave circuit analysis. More realistic problem also involves the anisotropy of the layered media, e.g., the uniaxial media. Therefore, the fast solution of electromagnetic scattering for 3D dielectric/conductive/resistive objects embedded in layered uniaxial media is of great importance. In some cases, the 3D object such as the thin dielectric sheet, hydraulic fractures, has a tiny thickness compared to the width and length. Conventional volumetric methods such as the finite element method (FEM) and volume integral equation method (VIE) will generally lead to a very dense mesh, which makes the modeling unnecessarily expensive.

Modeling of thin dielectric sheet (TDS) in homogeneous media is well developed (Chiang, I.T. and Chew, W.C., 2006, IEEE Trans. Antennas and Prop., 54(7), pp 1927-1934). The TDS-based surface integral equation (TDS-SIE) successfully transforms the original VIE into a SIE while achieving the same or even better accuracy. During the last ten years, the TDS-SIE scheme has been extended to model coupled PEC-TDS structure (Chiang, I.T. and Chew, W.C., 2006, IEEE Trans. Antennas and Prop., 54(11), pp 3511-3516)., multilayer TDS (Niu, X., et al., 2015, IEEE Antennas and Wireless Prop. Lett., 14, pp.779-782.) and thin conductive sheet (Ren, Y., et al., 2016, IEEE Geosci. Remote Sensing Lett., 13(10), pp.1448-1451) in homogeneous media. Other similar scheme for thin sheet modeling was also developed for geophysical applications, such as thin fracture in layered isotropic media (Song, Y., Kim, H.J. and Lee, K.H., 2002. Geophysics, 67(3), pp.746-754).

This work extends the TDS-SIE method to develop an efficient modeling for thin dielectric/conductive/resistive sheet in multilayered uniaxial media with the adoption of the layered media Greens function (LMGF) and mixed-potential integral equation (MPIE). Singularity subtraction method is applied to remove the singular part of the Sommerfeld integrals (SIs) when the LMGF is evaluated. The LMGF without the static and image terms behaves sufficiently regular and a 3D interpolation based on simplex interpolation method is utilized to accelerate the evaluation of LMGF without degenerating the accuracy. Special scheme for the post-processing of the calculated current/flux on the thin sheet when the thin sheet crosses the layer interfaces is applied to deal with the discontinuities of the current/flux. Numerical examples will be shown in the conference to demonstrate the efficiency and accuracy of the proposed modeling method for thin sheet in multilayered uniaxial media based on TDS-SIE and LMGF.