Three-Dimensional Scattering Analysis of Lossy/Lossless Dielectrics Using Constrained Interpolation Profile Method

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Abstract—The constrained interpolation profile (CIP) method for three-dimensional scattering analysis of lossy and lossless dielectrics has been successfully developed. It is used to reduce the effect of averaging of the fields in the calculation of total scattered power. Validity of the method is demonstrated by calculated total scattering cross section (TSCS) of dielectric spheres comparing with the exact Mie's result.

Introduction

The finite-difference time-domain (FDTD) method has been used extensively to calculate scattering and absorption from dielectrics in the past [1]. However, averaging have to be used in the calculation of radiated power because of the leapfrog arrangement of the field components. Recently, the CIP method have been developed for scattering problems [2]. Since the CIP method is considered to reduce the effect of averaging because all field components locate at the same place, it is applied to calculate the scattered power from dielectrics and its accuracy has been validated.

Analysis model and results

Fig. 1 shows an analysis model for the CIP method. A dielectric sphere was placed in the center of analysis region and an incident plane wave of a rectangular pulse with pulse width of 5Δ, where Δ is cell size, was induced into the region from the left boundary. The TSCSs calculated on the surface encompassing the dielectric spheres of $\epsilon_r = 2.0, \sigma = 0.01$[S/m] and $\sigma = 0.1$[S/m] are shown in Fig. 2, in which the FDTD and Mie's results are also plotted. The results show good agreement with the exact solutions of Mie, which demonstrates the validity of the method.

Conclusions

The CIP method for the 3D scattering of dielectrics has been successfully developed and its validity has been shown by the TSCS results in a wide range of frequency.

References

[1] A. Taflove and K. R. Umashankar, "Computation of the Electromagnetic Fields and Induced Temperatures within a Model of the Microwave-irradiated Human Eye," *IEEE Trans. Microwave Theory Tech.*, Vol.MTT-23, pp. 888-896, Nov. 1975.

[2] J. Chakarothai, Q. Chen, and K. Sawaya, "Numerical Analysis of Electromagnetic Scattering Using Constrained Interpolation Profile Method," ISAP'09, Bangkok, Thailand, Oct. 2009.

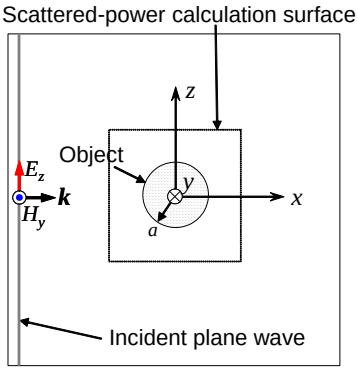

Figure 1: Analysis model for CIP method.

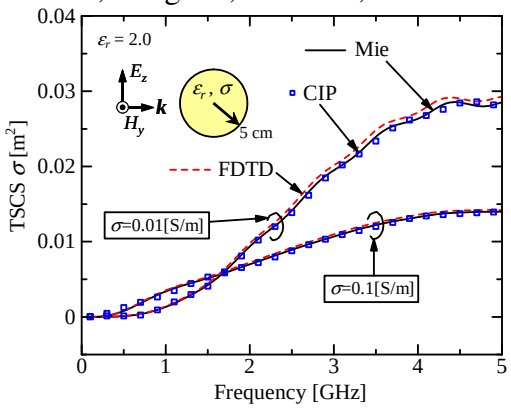

Figure 2: TSCS from lossy dielectric spheres.