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Analysis of a Metal Sphere Using the Three-Dimensional DCP-FDTD Method

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The finite-difference time-domain (FDTD) method is widely known as one of the numerical techniques for the analysis of electromagnetic problems. Note, for the conventional FDTD method, that the staircase approximation should be used even for the modeling of arbitrarily-shaped media. Consequently, we have to employ fine meshes to attain sufficient accuracy, resulting in a long computational time.

To alleviate the above-mentioned problem, several improved methods have been studied. For instance, Mohammadi *et al.* have proposed the dispersive-contour path (DCP) FDTD method based on the Z-transform [1]. We have also introduced the DCP technique to the FDTD method based on the simple trapezoidal recursive convolution (TRC) technique [2]. In addition, the method has been extended to a version for the Drude-Lorentz model to treat dispersive media over a wide frequency range [3]. However, these studies have been done only in two-dimensional problems and no application has been found for three-dimensional (3-D) ones.

In this article, we newly extend the DCP technique to 3-D problems to accurately analyze arbitrarily-shaped dispersive media. First, the DCP algorithm is introduced into the FDTD method based on the TRC technique [4]. As an example, we investigate a metal sphere, leading to the DCP coefficients in each cell. Next, we evaluate its scattering cross section and field distributions. To show the effectiveness of the 3-D DCP-FDTD method, the result is compared with the Mie solution and that from the conventional staircase FDTD method.

Fig. 1 shows the field distributions of an Au sphere. It is seen, for the DCP-FDTD method, that the field is smoothly calculated along the surface of the sphere. In contrast, for the conventional FDTD method, the field is overall distorted due to the staircase approximation.

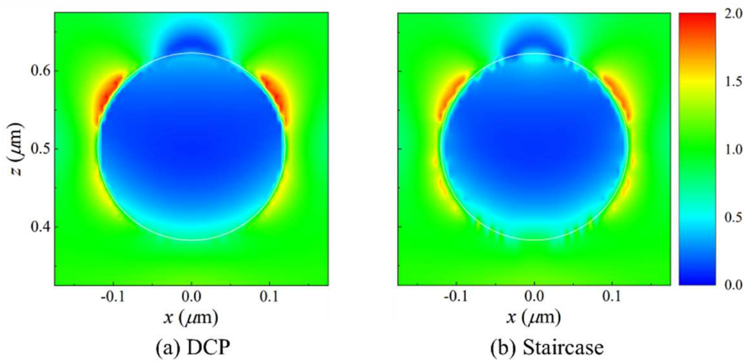

Figure 1. Field distributions of $|E_x|$ ($\lambda = 487$ nm)

References

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