Electromagnetic field analysis of a Drude-Lorentz model using meshless time domain method

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The corrugated waveguide is widely used for the electron cyclotron heating system in nuclear fusion device. Although the structure of the corrugated waveguide is empirically determined, its optimum structure has not been investigated. Therefore, to find the optimum structure, we are planning to evaluate numerically the transmitting efficiency of electromagnetic waves in the corrugated waveguide by Meshless Time Domain Method (MTDM). For the first step of the investigation, we modify our simulation code to treat the dispersive medium in this paper because the corrugated waveguide is composed of the metal in numerical simulation.

Generally, Finite Differential Time Domain Method (FDTD) is employed to analyze the electromagnetic wave propagation phenomena. FDTD provides the solution of Maxwell’s equations directly. However, the analysis region in FDTD must be divided into orthogonal meshes. From this reason, complex shaped objects such as the corrugated waveguide are not easy to treat by FDTD simulation because the calculation of complex shaped objects need smaller mesh to keep the calculation accuracy. Meshless method is one of the solutions to overcome this difficulty.

The complex shaped objects are easily analyzed by MTDM. Although the basic concept of the MTDM is the same as FDTD, there is a difference related to the discretization of Maxwell’s equations. The equation is discretized with respect to time by applying Leap-Frog algorithm as well as FDTD. However, the shape function of the Radial Point Interpolation Method (RPIM) is employed to the discretizing process of the space. Here, RPIM is one of a meshless method. The shape function of RPIM has the Kronecker’s delta function property \cite{1, 2}. As the result, discretized equations of Maxwell’s equations become very simple in MTDM \cite{3}.

The dispersive medium such as metal can be calculated by Drude-Lorentz model. Drude-Lorentz model treats free-electron and bounded-electron. To calculate Drude-Lorentz model in FDTD, it is necessary to apply the recursive convolution (RC) method \cite{4}. In the same way as FDTD, Drude-Lorentz model can be calculated in MTDM by applying the RC method.

The purpose of the present study is the investigation of the frequency characteristics in the dispersive medium. In particular, we chose silver for the dispersive medium for the calculation. Then we investigate the influence of the frequency on the reflectance when the wave is the incident from vacuum to silver.