Wave Propagation Characteristics of Plasma Based on ADE-WLP-FDTD

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Finite-difference time domain(FDTD), as one of the important algorithms of computational electromagnetics, is widely used to study the interaction between electromagnetic wave and dispersion medium. The unconditional and stable weighted Laguerre polynomials(WLP)-FDTD with auxiliary differential equations(ADE) method can be applied to compute complex and dispersive medium structure[1]. With the development of research in recent years, many different complex dispersion models of plasma have been proposed[2]. The modified Lorentz model can cover Drude, Debye, Lorentz, critical point, and quadratic complex rational function models[3]. We consider a modified Lorentz medium whose relative electric permittivity $\varepsilon_r(\omega)=\varepsilon_{r,\infty}+(a_0+a_1(j\omega))/(b_0+b_1(j\omega)+b_2(j\omega)^2)$ $\varepsilon_{r,\infty}$ denotes relative permittivity at infinite frequency[3]. In this paper, ADE-WLP-FDTD method is applied to the modified Lorentz medium, which has strong applicability. For complex plasma models, we apply the Padé approximation method to transform it into the modified lorentz model.

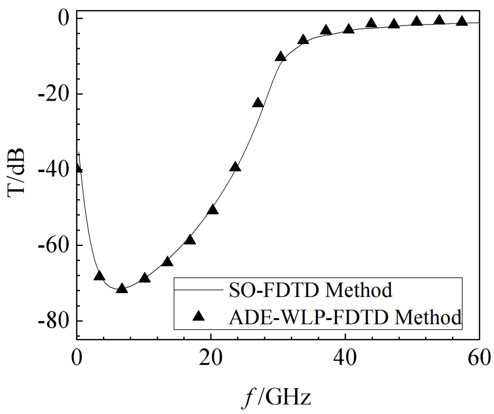

Fig.1 Transmission coefficient of electromagnetic waves propagation through plasma slab

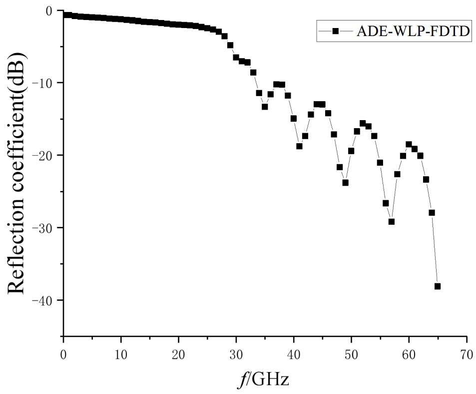

Fig.2 Reflection coefficient of electromagnetic waves propagation through plasma slab

Figures 1 and 2 represent the transmission and reflection coefficients of electromagnetic waves passing through a 1.5cm thickness plasma slab, respectively. The accuracy of ADE-WLP-FDTD algorithm is verified by comparison with SO-FDTD. The relative permittivity of the plasma is $\varepsilon_r(\omega)=1-\omega_{pe}\omega_{pe}/[\omega(\omega-i\Gamma_e)]$. The medium parameter are $\omega_{pe}=180.3\times10^9$ rad/s and Γ_e=20GHz. $a_1=0$, $a_0=-\omega_{pe}\omega_{pe}$, $b_2=-1$, $b_1=-\Gamma_e$, $b_0=0$. Furthermore, the modified Lorentz model based on ADE-WLP-FDTD can cover Drude, Debye, Lorentz, critical point, and quadratic complex rational function model. For some other complex plasma models, the Padé approximation method is used to transform them into modified Lorentz model.

Acknowledgments

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