Transient analysis of dispersive, periodic structures for oblique plane wave incidence using Laguerre Marching-on-in-Degree (MoD)

Srikumar Sandeep*[(1)], A. J. Gasiewski[(1)]
(1) University of Colorado, Boulder

Transient analysis of dispersive, periodic structures in the case of obliquely incident plane wave is presented in this work. The combination of obliquely incident plane wave, time domain computation and periodic dispersive scatterer presents a challenging problem. It should be remarked that commercial time domain softwares such as CST Microwave Studio can not perform oblique time domain analysis of periodic structures. A Finite Difference Time Domain (FDTD) based method for the same problem can be found in (F. I. Baida and A. Belkhir, "Split-field fdtd method for oblique incidence study of periodic dispersive metallic structures," *Opt. Lett.*, vol. 34, pp. 453–2455, 2009.). However this technique is unstable for incident angles greater than 75 degrees.

In this work the Laguerre Marching-on-in-Degree (MoD) (B. H. Jung et. al., "Transient wave propagation in a general dispersive media using the Laguerre functions in a marching-on-in-degree (mod) methodology,") is used for the development of an unconditionally stable algorithm. In the Laguerre-MoD method, all the time dependant quantities are replaced by weighted summation of Laguerre basis functions. Due to the unconditional stability, Courant-Freidrich-Levy (CFL) temporal discretization limit can be circumvented resulting in less simulation time compared to the conventional dispersive Finite Difference Time Domain (FDTD). This is particularly advantageous for multiscale, dispersive structures. The Uniaxial Perfectly Matched Layer (UPML) is implemented in the Laguerre domain. By virtue of the Laguerre decomposition, the presented method can simulate general dispersive media compared to conventional dispersive FDTD which can simulate only standard dispersion models such as Debye, Lorentz and Drude. The formulations are validated by estimating the transmission spectra of an infinite double pole Debye slab and comparing the results with analytical results. Further validation is achieved by comparing the results of the proposed method with results obtained with Periodic Method of Moments (PMM).