A Hybrid Time-domain Method for Electromagnetic Problems in Microelectronic Packaging

T. Xiao, **M. Chai**, and **Q. H. Liu**
Duke University, USA

Computational electromagnetics for the design simulation of microelectronic packaging problems faces a great challenge because of the complex fine geometrical details in the chip level compounded with the large scale of the package. A time-domain approach such as the finite-difference time-domain method with a uniform grid requires a large number of discretization points to solve such mixed-scale problems. This issue is especially challenging for package-level problems.

In this work, we develop a hybrid time-domain technique that combines several methods for the efficient modeling of microelectronic packaging problems: (a) the enlarged cell technique (ECT) for the conformal FDTD method, (b) the alternating direction implicit conformal finite-difference time domain (ADI-CFDTD) method, and (c) the pseudospectral time-domain (PSTD) method. The ECT eliminates an important limitation, i.e., the reduction in the time step size, in the CFDTD method, and removes the staircasing error in the FDTD method for curved conductors. Similarly, the ADI-CFDTD method removes this staircasing error, and is especially useful for regions with electrically small features. The PSTD method, on the other hand, is efficient for large homogeneous regions. Therefore, combining all these methods in our hybrid time-domain technique is attractive as it makes use of their advantages while avoiding the disadvantages in each of these methods. The interface conditions between different regions of these methods are provided by the Riemann solver to ensure the stability. We will demonstrate the efficacy of this hybrid method by solving large-scale package level EMI/EMC problems.