Electromagnetic-thermal-stress Multiphysics Simulation of Microwave Filter

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Abstract—With the development of microwave circuits, the integration of microwave devices is constantly increasing, which brings greater challenges to thermal management. The thermal expansion caused by high temperature will deform the microwave circuit, causing the electromagnetic characteristics of the microwave device to fail to achieve the expected effect in the design stage. The traditional design scheme of microwave devices is only based on electromagnetic simulation. The simulation of a single physical field cannot simulate the influence of temperature and deformation mentioned above, so it is difficult to meet the actual needs. Therefore, it is indispensable to study the multiphysics simulation method of microwave circuits. There have been some studies on electromagnetic-thermal co-simulation methods [1–4], but there are few research on electromagnetic-thermal-stress multiphysics simulation methods.

An electromagnetic-thermal-stress multiphysics simulation method for microstrip filter is proposed in this paper. The discontinuous Galerkin time-domain (DGTD) method is used to solve the Maxwell equations for electromagnetic simulation. Thermal simulation is based on the finite-element time-domain (FETD) method to solve the heat conduction equation. Stress simulation is realized through the finite element (FEM) method. The coupling of thermal simulation and stress simulation is achieved through thermal stress. The mesh information of the model is updated through node displacement, and then electromagnetic simulation is carried out. Finally, this method is used for the analysis of microstrip filters. Through electromagnetic-thermal-stress multiphysics simulation, the temperature change curve and temperature distribution of the microstrip filter can be obtained, which can better simulate the actual working environment of the device. The deformation and stress distribution of the whole device can be observed. The port voltage before and after deformation can also be obtained. After the Fourier transform of the port voltage, the $S$ parameter can be calculated, and the change of the filtering performance under the influence of thermal stress can be observed.

REFERENCES