講演番号	066

文献番号	20225066

Proposal of a Fast and Accurate Transient Thermal Analysis Model for Semiconductor Devices

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KEY WORDS: **Thermal resistance, Heat Transfer, thermal analysis**, computer aided engineering（F2）

In recent years, the heat generation and heat density of vehicle control computers have increased due to the growing complexity of vehicle control and the need to downsize due to vehicle mounting limitations. The demand for transient thrmal design is increasing to cope with the reduction of thermal design margins due to the deterioration of the thermal environment.However, transient heat transfer analysis has tended to be avoided due to its large computational load. On the other hand, with the recent advances in analysis tools and computing power of PCs, Trangent thermal analysis has become acceptable for design utilization, and the need for analysis has been increasing.

In the transient theaml design of electronic devices, the junction temperature (T_j) of semiconductor devices is a particularly important criterion.However, in order to correctly analyze T_j by thermal analysis, it is necessary to correctly input information on the internal structure and physical properties of the device, but it is difficult for assembly manufacturers to obtain such information, and it is not unusual for even semiconductor device manufacturers to not know the physical properties of their devices.

In this study, as a modeling method for semiconductor devices that solves these problems of "increased computational load" and "difficulty in obtaining input information," we developed a new modeling method called DXRC model is proposed.

This modeling method employs a thermal network model to reduce the computational load.This avoids the need to increase the mesh size in thermal simulations. The model consists of two parts(Fig.1): an internal thermal network part extracted from the thermal response of T_j inside the device, and an external thermal network part representing the case temperature on the device surface and the contact thermal resistance with the mounting board. This allows comparison with experiments to assure the validity of the design and improve the quality of the analysis.

Using the Detail model as a reference, a comparison with two other transient thermal analysis models (D^{2}delphi ,T3ster) is shown in Figure 2.Compared to the other two models, the DXRC model matches the Detail model.Only DXRC can represent T_c, the temperature of this model also matches the Detail model.

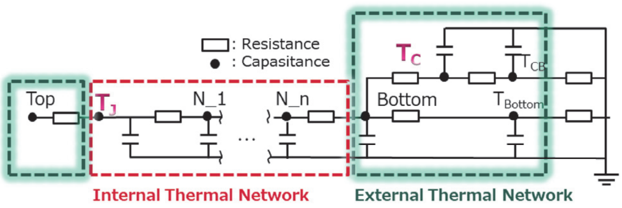

Fig.1 Thermal network of DXRC

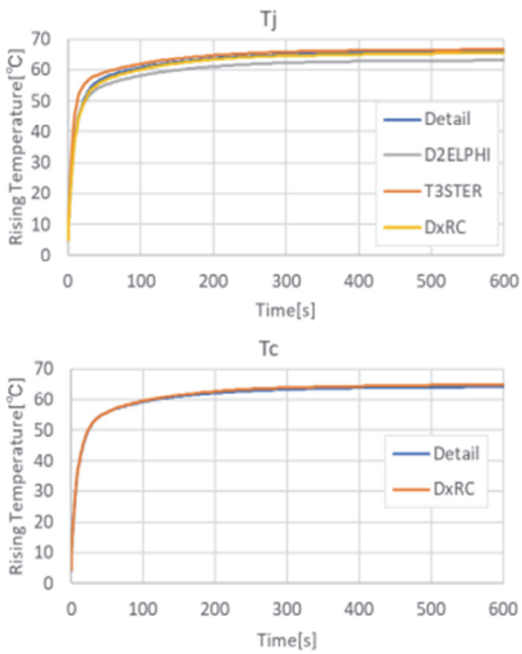

Fig.2 Comparison of transient