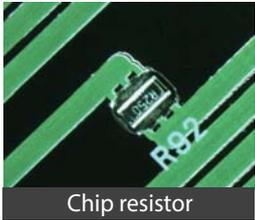# Predicting Durability of Junctions for Mounted Parts

scSTREAM simulates temperature distribution of board and mounted parts.
It is followed by a structural analysis on thermal stress to predict durability of the joints.

Prediction of Durability

Chip resistor

A chip resistor undergoes repeated heat generation by its on-off actions, and it may cause the breakage of solder joints in the worst case.

Conventionally, temperature cycling tests have been used for checking the long-term reliability of solders. The life prediction technology of the solders has been established by means of structural analysis.
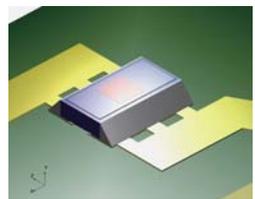
Chip resistor and circuit board (analysis model)

In recent years, however, power cycle tests (intermittent current), which evaluate the operation of actual device, have been introduced. In addition, a new prediction method using CFD and structural analysis is expected to be applied.

Durability evaluation test

Power cycle test (intermittent current) evaluates the durability of solder joint by imposing load of conduction/interruption and by generating the thermal stress, which changes the temperature of the joint cyclically.
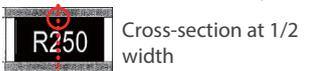
The durability is confirmed by observing the crack of solder cross-section after the test.

Evaluated circuit board
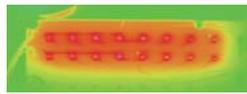
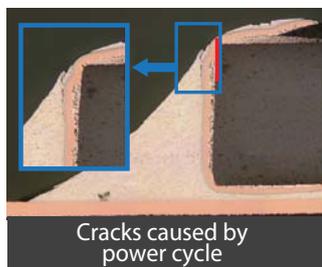Thermographic temperature measurement

Result

Cross section of the chip resistor

Cross-section at 1/2 width

Cross-section at 1/4 width

Cracks caused by power cycle
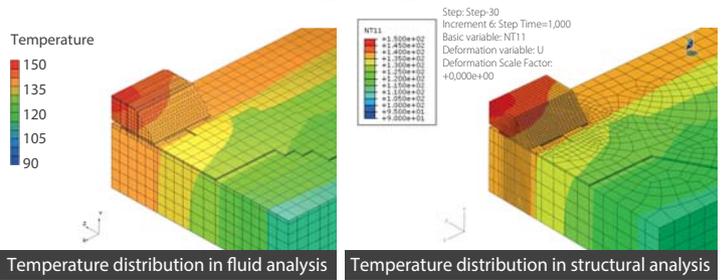

Cracks caused by temperature cycle

Shapes of cracks due to the cyclic stress vary depending on the amount of heat generation and/or of the surrounding temperature. The correlation between the cracks and the stress distribution is confirmed by the simulation.

Simulation

Thermal stress analysis is performed for a chip generating heat (0-30 seconds).

Temperature
150
135
120
105
90

Step: Step-30
Increment 6: Step Time=1,000
Basic variable: NT11
Deformation variable: U
Deformation Scale Factor:
+0,000e+00

Temperature distribution in fluid analysis

Temperature distribution in structural analysis

Temperature distribution from scSTREAM is mapped on to the mesh of structural analysis. The stress on solder connection is calculated using structural analysis.

Mises stress distribution after 15 seconds

Mises stress distribution after 180 seconds

High stress is generated where cracks occur

● Significant reduction of simulation hours ●

Down 70%

The simulation hours are reduced by 70% with the introduction of a new mapping method and macro.

Conventional method: Manual mapping
New method: Automatic mapping

Conventional

scSTREAM
Analysis
↓ Heat transfer coefficient (Manual mapping)
Structural analysis software
Electric-thermal analysis → Thermal stress analysis

Problems:
- Complicated procedures
- Too many operations to pass the transient results
- Human error by manual mapping

New

Automation eliminated manual operations and human errors, and even made the mapping of transient results practical.

scSTREAM
Structural analysis software
Analysis → FLDutil → Thermal stress analysis
Nodal temperature (Automatic mapping)

Notes

scSTREAM enabled us to obtain the temperature distribution of each component of a chip resistor and further predict the stress on solder joints. As a result, we can now obtain the causal relationship between thermal stress and product's duration. Moreover, by actively utilizing VB macro, improvement in analysis accuracy and reduct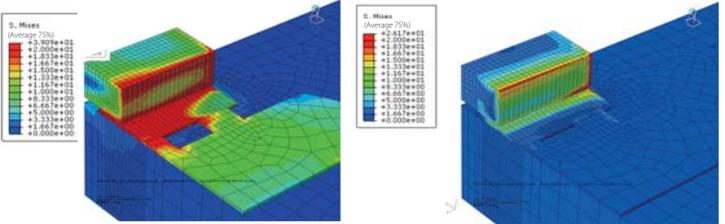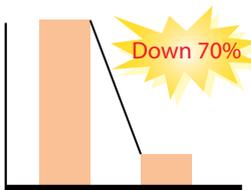ion of the simulation hours are achieved.