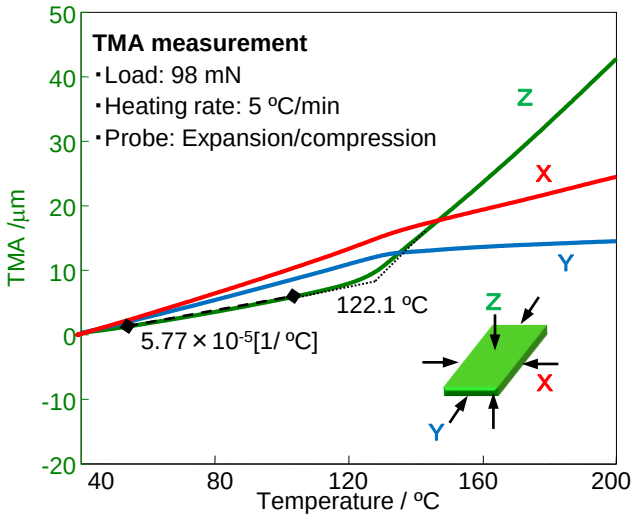
Thermal Analysis of Printed Circuit Board

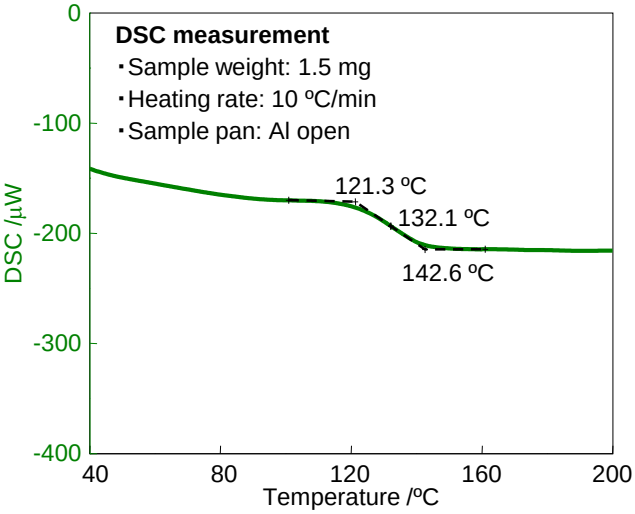
2016.01

Printed circuit boards (PCBs) are mounted with various electrical components and conducting layers. Depending on the operating environment, the conducting layers may be damaged by the expansion and/or softening of the PCB. Therefore, PCBs are usually reinforced by glass fiber with a low expansion coefficient and a high softening point (glass fiber-reinforced epoxy board). It is important to know the linear expansion and softening temperature of PCBs. This report introduces an example measurement of the glass transition, expansion, and softening for a glass fiber-reinforced epoxy resin.

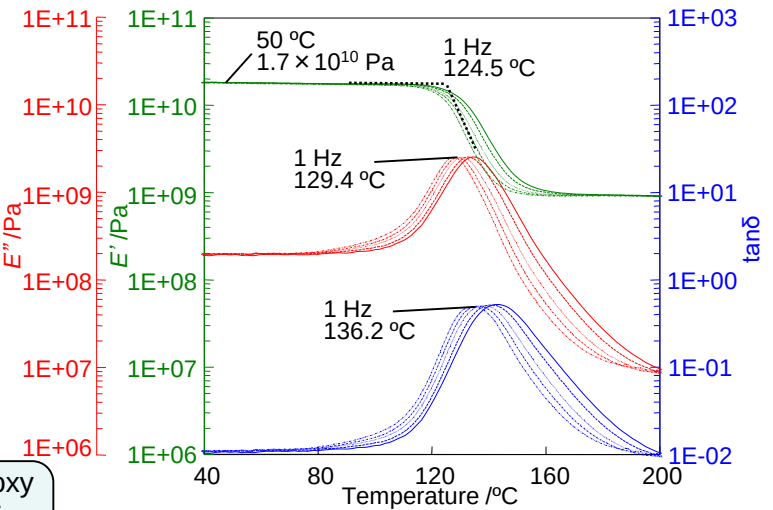
Results



We performed TMA in the X, Y, and Z directions (see figure to the left). The Z direction undergoes the least amount of expansion until the glass transition temperature due to its short length. However, beyond the glass transition temperature, the coefficient of linear expansion increases. In contrast, the coefficient of linear expansion in the X and Y directions decreases above the glass transition temperature. To protect the conducting layers on the PCB, the layout of epoxy resins is set such that it can restrain the thermal expansion even when the temperature is over the glass transition.



DMA measurement
・Dimensions: 20 mm (length) × 10 mm (width) × 1.5 mm (thickness)
・Heating rate: 2 ºC /min
・Measurement mode: Dual-Cantilever Bending
・Frequency: 0.5, 1, 2, 5, 10 Hz



The step in the DSC signal corresponding to the epoxy glass transition becomes smaller with increasing weight ratio of the fiberglass, and thus detection of the glass transition becomes more difficult. However, we are able to directly observe the glass transition of epoxy resin from 120 to 150 ºC.
In general, glass transitions are detected as an increase in the linear expansion coefficient using TMA and a change in the specific heat capacity using DSC.

DMA was used to measure changes in the epoxy resin hardness during heating. The elastic modulus (*E'*) is constant at 1.7×10^{10} Pa from room temperature to 120 ºC. A glass transition is observed from 120 to 170 ºC, and *E'* is decreased by softening of the epoxy resin. DMA can thus be used to assess the strength and heat resistance of PCBs.