

The Anisotropy of Thermal Expansion and Shrinkage

Yutaka Ichimura

Application Engineering Section

1. Introduction

Thermomechanical analysis (TMA) can investigate changes in dimension (length) by material temperature.

Sample properties such as quality, composition, and structure can cause differences in transformation method and size by measurement direction. TMA can obtain information about anisotropy, the differences in physical properties by direction.

In this brief, TMA is used to analyze polyethylene film and a printed circuit board (PCB) made of glass fiber reinforced epoxy resin.

2. Measurements

2-1 Polyethylene film

In general, polymer film aligns in the drawing direction when it is formed so the physical properties of the drawing direction and the transverse direction are different. Figure 1 shows the TMA results of tensile measurement for the drawing and transverse direction of the polyethylene film. The results indicate that the drawing direction stretches more than the transverse direction.

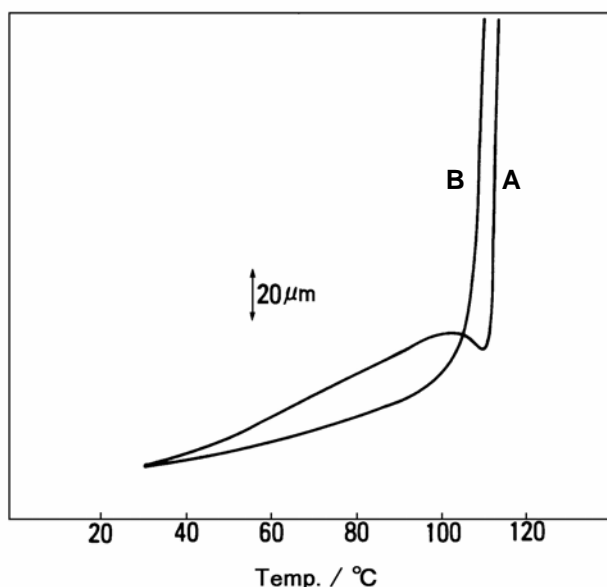


Figure 1 TMA results for the drawing (A) and transverse (B) directions of Polyethylene Film

Sample dimensions : 4×10mm

Heating rate : 5°C/min

Load : 2g

2-2 PCB

Figure 2 shows the TMA results of compression measurement for the three directions of the PCB. The results show that the rate of expansion differed by measurement direction. The change in expansion rate around 130°C in the TMA curve is likely due to the glass transition of epoxy resin, a major component of this PCB.

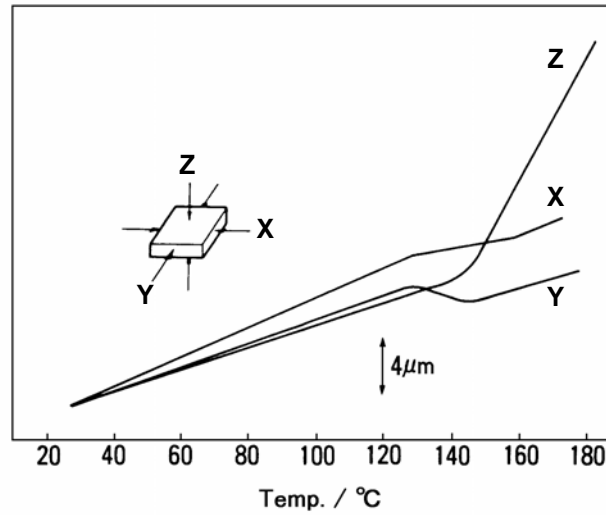


Figure 2 TMA results for the three directions of a PCB
Sample dimensions : $7 \times 7 \times 1.6\text{mm}$
Heating rate : $2.5^{\circ}\text{C}/\text{min}$
Load : 1g