PORT PLASTICS

Semiconductor

CAN YOU TAKE THE HEAT?

UNDERSTANDING THE BASICS OF THERMAL EXPANSION AS IT RELATES TO PLASTIC

One of the most critical properties that relate to plastic selection within the Semiconductor industry is the Coefficient of Linear Thermal Expansion (CLTE). CLTE is defined as the rate a material expands (or shrinks) as a function of temperature. CLTE is a critical factor to consider in designing applications exposed to higher temperatures in process or used to test over a wide temperature range, such as IC test sockets. Not only will the material grow as the temperature rises, but critical features machined on the parts will grow and move. CLTE becomes a crucial influence in the placement of micro holes in the array pattern of test sockets. Materials will often be selected that have the lowest CLTE values. Not only will the holes change in size as temperature shifts, but in location as well.

Plastic materials can be generally characterized as either isotropic or anisotropic. Isotropic materials will grow equally in all dimensions, X,Y, and Z. Anisotropic materials, on the other hand, are direction-dependent. Take graphite material, for example, which is often used as a filler in plastic materials. The lattice structure of the graphite material is different within its own structure, creating a different CTE value in the direction normal to the plane of the graphite. This creates a growth coefficient that differs in one or more of the axis. The level of anisotropic properties as well is dependent on the polymeric structure. It's critical to know the type of CLTE in designing a part using plastics so that the consideration can be used in the dimensions based on the heat cycle the part will endure.

So how is CLTE measured? For ASTM level test methodology, ASTM E831 test protocol is used. In short, the test method uses a thermomechanical analyzer to determine the linear thermal expansion of solid materials when subjected to a constant heating rate. The change of the specimen length is electronically recorded as a function of temperature. The coefficient of linear thermal expansion can be calculated from these recorded data using the following formula:

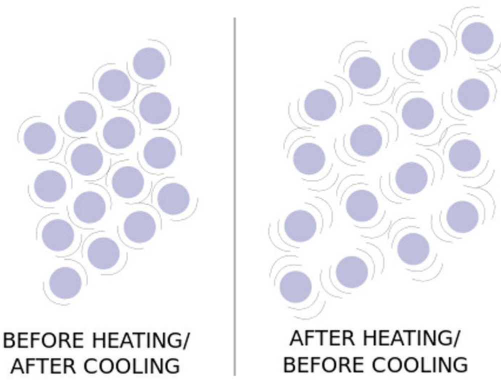
$\alpha = \Delta L / (L0 * \Delta T)$

α = coefficient of linear expansion per degree Fahrenheit (in. / in. / °F), often measured from -40°F to 300°F or to the limit of the plastics thermal capability.

ΔL = change in length of the specimen from heating or cooling

$L0$ = Original length of the plastic specimen

ΔT = Full range of temperature change during testing



A book could be written discussing the impact of CLTE in the optimization of material selection but we are out of space.

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