The Importance of T_g in Polymers

The glass transition temperature (T_g) of a polymer is a very important parameter that must be considered by the user of the material. In reality, the glass transition occurs over a range of temperature that differs markedly for different materials. That is, the temperature span may be rather wide or relatively narrow depending on the molecular structure of the material as well as other factors. The most important points to remember is that at the T_g, a material becomes markedly less flexible and compressible and its CTE can change dramatically.

Experiment designers, engineers and others have overlooked this property in some instances and this has led to cracking, crazing and debonding of potting compounds, conformal coatings and adhesives during test and/or flight. These occurrences have ultimately produced electrical failures, corona discharge, cracking of solder and crushing of electrical components. This property is an important consideration for optical designers where alignment over the entire operating temperature range is critical.

Different formulations of polyurethanes vary widely in their T_g temperatures and, therefore, have experienced many of the problems described above. Often, the temperatures encountered in testing go well beyond those expected in flight. This fact must be taken into account in choosing materials. It should be noted that one of the most popular polyurethane formulations, Solithane 113/C113-300, has a relatively high T_g temperature range. If used in applications similar to those described above this product should not be cycled or utilized at temperatures below 0°C.

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Similar precautions must be taken when using epoxies and silicones. In general, silicones are more forgiving than epoxies or polyurethanes at temperature extremes. However, the properties of the material under consideration need to be well characterized in the operating temperature range.