



Finding a better way

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Using PTFE-based laminates at high temperatures

PTFE-based printed circuit board laminates are used in many challenging environments. These include both electrically and physically demanding applications. The low-loss electrical properties of PTFE and composites made thereof are well documented throughout the printed circuit board industry. Although PTFE-based materials are a robust choice material for diverse physical environments, their application is less broadly understood under these circumstances.

PTFE is robust across a broad temperature range (-240°C to 260°C $\{-400^{\circ}\text{F}$ to $500^{\circ}\text{F}\}$). The degradation temperature of PTFE is 425°C (797°F)¹. Also, the electrical intrinsic properties, including dielectric loss are typically quite consistent over a broad temperature range. PTFE is chemically stable over a larger range than indicated by the typical continuous exposure of 500°F . As a result, the principal concerns regarding PTFE use at temperatures immediately above 260°C relate to physical strength, often as exhibited by the physical properties of PCB laminates with regard to expansion, internal stress and creep behavior. Another high temperature concern in PTFE laminates is the resistance of copper traces to potentially damaging oxidation processes at high temperatures.

The free thermal expansion of PTFE is high compared to many thermoset materials; however, its modulus also decreases by $2\frac{1}{2}$ orders of magnitude as the temperature increases from 37°C to 100°C . Although the effect is smaller in PTFE-ceramic laminates, qualitatively the same effects have been observed. As a result, in constrained environments like plated through holes, the net stress is less than would be anticipated based only on the coefficient of thermal expansion. Consequently, plated through holes retain more integrity at higher temperatures than would be predicted by models based on thermosets with equivalent thermal expansion coefficients.

Another physical property challenge that should be avoided in high temperature applications that require PTFE laminates are pressure points like those created when a PTFE-based laminate is fixed to a housing using screws. Over time, a pressure point from a physical fastener can move resin on the laminate. Alternative means to secure the material should be employed. In those cases where physical restraints are required, care should be included in their design to minimize the stress that is imparted on the board.

¹ Ebnesajjad, Sina; Fluoroplastics; Plastics Design Library; 2000; p.11. T_d based on weight loss by TGA.