PCB007 PRESENTS

August 2011

the pcb magazine

AN I-CONNECT007 PUBLICATION

PLASMA

HARNESSING THE SCIENCE OF PLASMA

Having Lead-Free Soldering Issues?

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SUMMARY

The laminate industry recently brought several products to the market to address issues such as lead-free soldering, high layer count, environmental concerns and more. As with all things in the technical community, there are always trade offs. When you consider the different attributes required, there is no perfect PCB laminate.

The laminates used in the PCB industry have advanced over the years. However, unless you are in tune with the laminate industry or have a PCB issue which requires your attention, you may be unaware of recent developments. The past few years have placed more attention on the PCB materials regarding lead-free soldering, very high layer count, environmental issues and more electrical concerns.

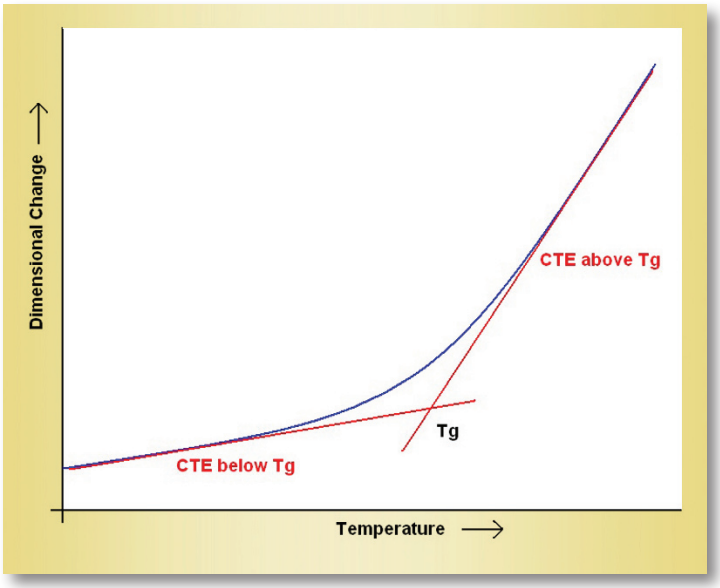

Figure 1. Simplified drawing of a TMA curve showing T_g and CTE performance.

The laminate industry recently brought several different products to the market to address these issues, but as with all things in the technical community, there are always trade-offs. When you consider the different attributes required of a PCB laminate, there is no perfect laminate. Each laminate has its own list of pros and cons, and users should choose the product that best fits their needs.

The lead-free soldering issue has several material property concerns, such as the glass transition (T_g), CTE (coefficient of thermal expansion) and T_d (decomposition temperature). Knowing these numbers for a laminate is a good reference, but it doesn't tell you the whole story. A laminate with a higher T_g is generally good, but the actual TMA curve should be evaluated to understand what happens, thermally, on both sides of the T_g. A material with a T_g of 180ºC is considered good, but if the CTE beyond the T_g temperature is extremely high then the high T_g has less benefit. The temperature of a circuit during lead-free soldering is typically around 240ºC to 260ºC, depending on many things, but that temperature is normally well beyond the T_g of most PCB materials. If the CTE of the material is very high when considering the range of the lead-free soldering temperatures, that can be negative for the PCB surviving soldering, even if the T_g is a high value. A well-suited material for lead-free soldering should have a minimal transition of CTE values through the T_g temperature and a relatively low CTE beyond the T_g value. Ideally, the material should have a T_g that is higher than the lead-free soldering temperature. A simple drawing representing a TMA curve for a laminate is shown in Figure 1.

The value for the CTE is also critical. For the x-y plane of the material, or the surface plane, a material with a CTE that matches copper is best; that number is about 16 ppm/ºC. In the z-axis (thickness axis), the CTE of the material should be ideally around the same number. However, due to the complexities of laminate, it is usually much higher. Generally, it is believed that a z-axis CTE of about 70

ppm/ºC or less is good for thermal issues and a lower number is better.

The T_d value of a laminate is sometimes not considered, but it can be a good indicator for lead-free soldering performance. If the T_d of the material is above the lead-free soldering temperature, it is sometimes assumed good for this process. In reality, the definition of T_d should be considered as well as the physics regarding this property. The T_d is defined as the temperature where the material is losing 5% of its mass or more. As the temperature is raised and approaches the T_d, some mass loss occurs that will develop stresses inside the material which can contribute to delamination.

A material with a T_d that is near the lead-free soldering temperature can be a concern because, even though it may not be losing enough mass to be defined as within the decomposition range, it could be losing enough to cause significant stress build-up. It has been shown that a material with a T_d of 300ºC can have issues with lead-free soldering. However, in the same study, a material with a T_d of 400ºC had no issues. To be fair, the material with the lower T_d also had a higher CTE at the lead-free soldering temperatures, which aggravates the issue.

There are also peel strength issues at the lead-free soldering temperatures that can be important as well. Understanding the T_g, T_d and the CTE is very important for lead-free soldering issues during assembly and reworking operations. **PCB**

John Coonrod is a Market Development Engineer for Rogers Corporation, Advanced Circuit Materials Division. He has more than 24 years experience in the PCB industry, about half of which was in the flexible PCB industry doing circuit design, applications, processing and materials engineering. Coonrod has also supported the high-frequency rigid PCB materials made by Rogers for the past ten years. You can reach John Coonrod at: john.coonrod@rogerscorporation.com.

VIDEO INTERVIEW

What's in the Box?

by Real Time with...APEX EXPO 2011

Greg Bull of Rogers Corporation opens the box to reveal the New Product Innovation Award presented to Rogers for the company's RT/Duroid 6035HTC high-frequency laminate.

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