POLYONICS

Process Changes for Electronics Manufacturing:
LEAD FREE SOLDERING

Implications for Barcode Labels

Overview

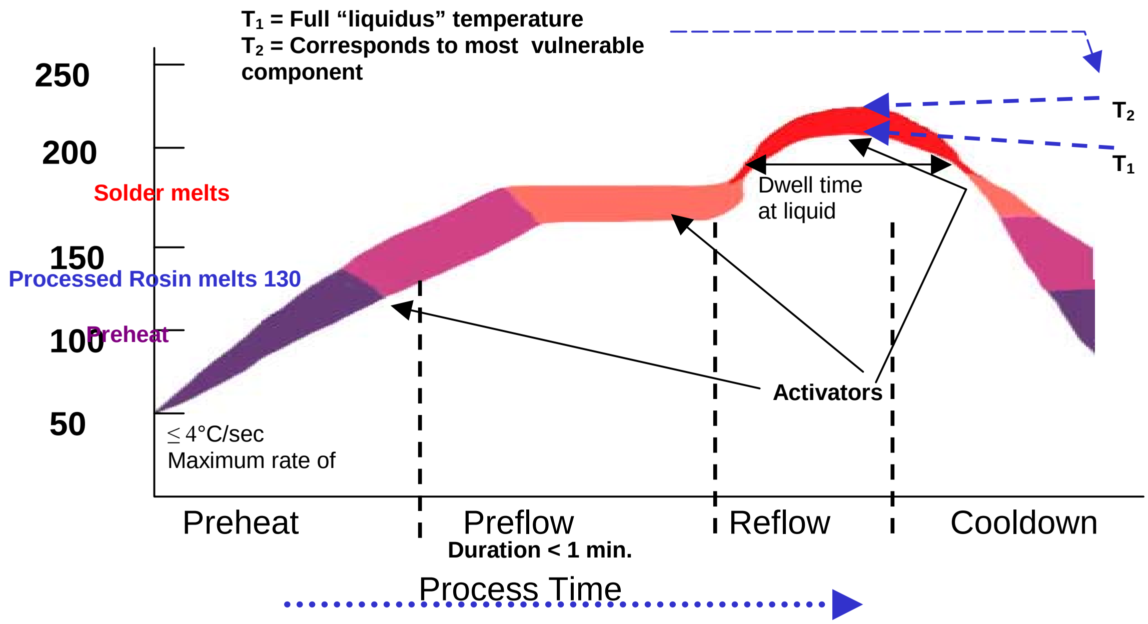
Increasing worldwide interest for “lead free soldering" will bring about significant changes in the circuit board manufacturing environment. In response, the thermal environments encountered in manufacturing will change (because of the higher temperatures required for “no-lead” soldering), which will influence the Saponifiers, cleaners, and fluxes used. These changes will influence process times and product throughput, as well as have effects on critical components. Barcode labels are now well-established as indispensable components, which may also be affected by thermal changes in the PCB manufacturing process. Even the polyimide you use today may have trouble tomorrow. This has led to the development of Polyonics "Lead Free" labels.

Current Soldering Processes

The current manufacturing processes for electronic products are well characterized and understood. Many blends of tin and lead are available to satisfy the many different process requirements experienced today. In this relatively stable process world, the cleaning processes and chemicals have been optimized to achieve "Six Sigma" performance in manufacturing reliability. Process temperatures used for soldering operations today range between one and 80 to 240 degrees centigrade.

The Environmental Push for the " greening of the globe" has given impetus to lead free soldering processes as the world economy exponentially consumes electronic products (which use solders containing lead). Ultimately, this will lead to exponential growth in lead-containing solid waste streams, as new electronics obsolete older generations of equipment, and are subsequently discarded. However, the change to "lead free " solder has major implications for the entire manufacturing process. The current commercial blends of tin, copper, bismuth, and antimony provide a liquid phase (molten solder) in the range between 260-280° C. These higher temperatures rise above the temperatures of the “Most Vulnerable Component” (MVC). *The MVC is the highest temperature that the most sensitive component can withstand, without compromising performance.*

Experimental quaternary mixtures of tin, bismuth, indium, and zinc, with liquid phase ranges of 180-200 ° C. are under development, but are still very expensive. Most significantly, the new oxides generated from these metals during the soldering operation are new, and difficult to clean, which causes concern for cleaning operations.
Shown below is a typical re-flow profile.



This depiction is meant to only portray the general characteristics of all profiles, rather than specifics of any particular thermal profile. The Y axis portrays Operating Temperatures in ° C, while the X axis shows progress in relative process time (seconds to minutes), as the PCB moves through the manufacturing process, from pre-heat through pre-flow, re-flow, and into cool-down. As the product moves into the range of temperatures for the preheat cycle, solder paste materials begin to melt. Rosins melt at about 130 ° C. beginning in pre-flow. As the product moves from preheat into reflow, various chemical activators allowing for better "wetting out" of the metal surfaces. Conventional solder starts to melt at about 180 ° C. as the board moves into the reflow zones of the process. Temperature T_1 one signifies the lowest temperature required to achieve the full liquid (molten solder) state. Temperature T_2 corresponds to the highest allowed temperature permitted for the most vulnerable component (MVC).

The next idealized profile shows the effects of an approximate 30-50 °C shift depicting the new temperatures required for "lead free" soldering. The most significant thing to note is the upward temperature change required of the most convert vulnerable component, or the new critical $T_1$and T_2 points.

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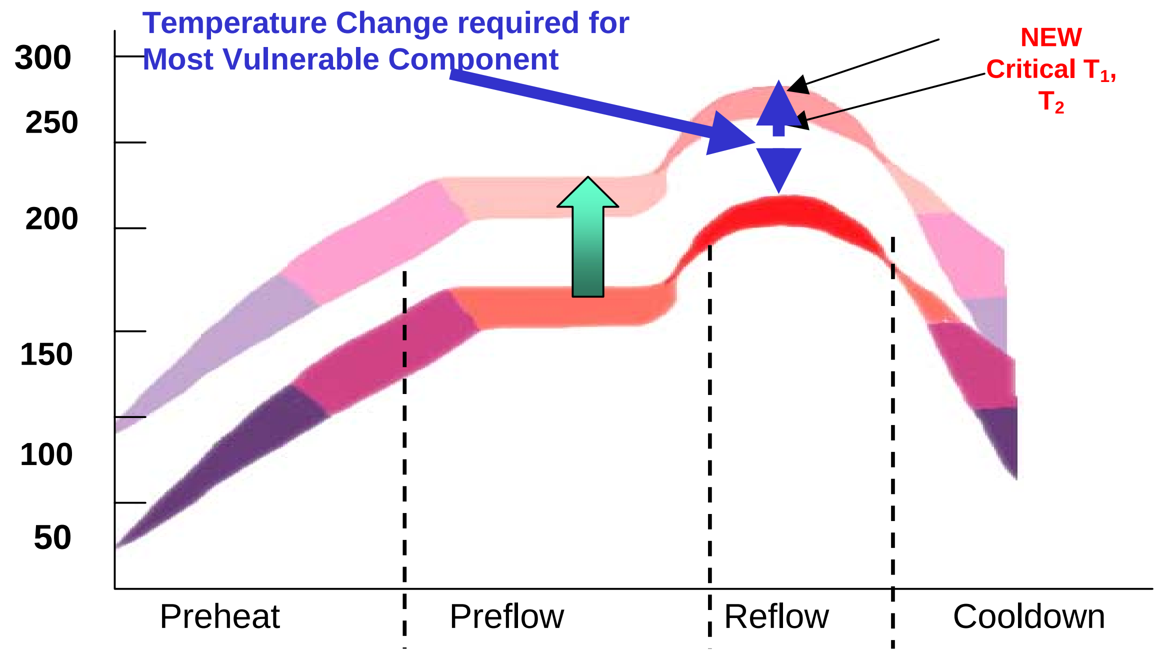
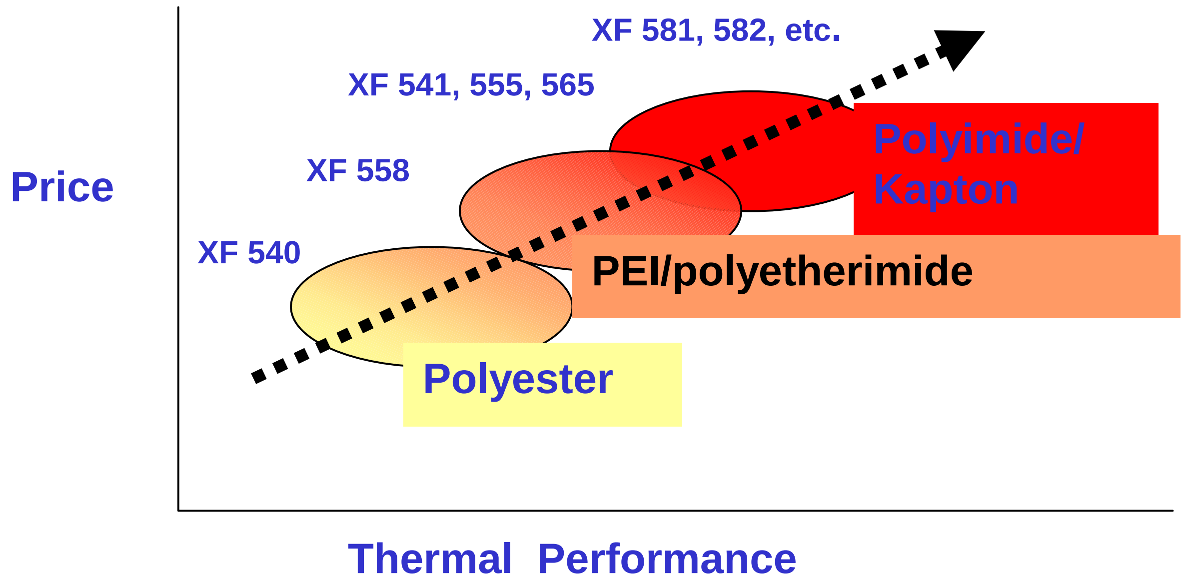


Now we come to the bar code label, which has come to be viewed as an important component also. As such, the bar code label carries information, which has high value. That value may be mandated by the end-user customer, by the manufacturer's own internal inventory control needs (manage stocking levels, production planning), for process control purposes (to have real-time status reports on process conditions and product flow), and even have individual boards control their own process environment by means of the bar code information contained thereon.

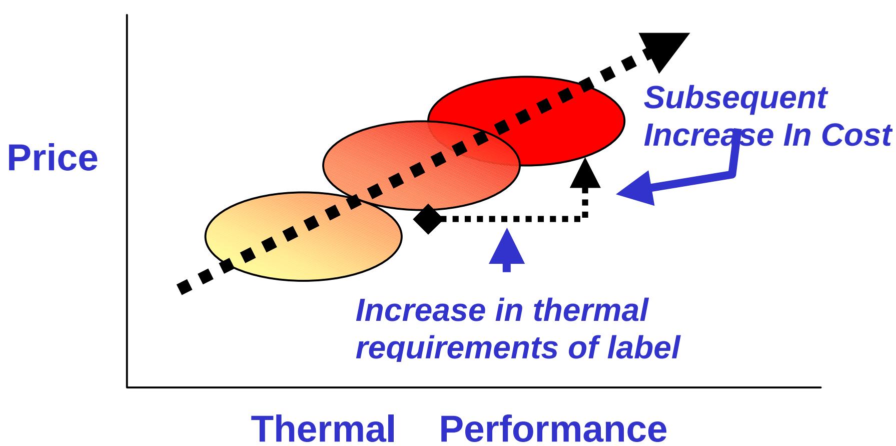
If the information is missing for any reason (unscannable, label falls off), then either the products do not comply with customer specifications, or the manufacturer does not gain the benefits of the bar code technology employed, or both. So what happens to labels, if they do NOT withstand the environmental thermal changes? **See for yourself!!**

This photograph is of an actual competitor's polyimide label subjected to 300 °C. for 50 min.

As shown in the photograph, the labels can discolor, can curl, made decompose, and or fall off of the circuit board or component to which they are attached.   The next figure depicts the continuum of thermal performance for labels produced and used in PCB manufacturing today.

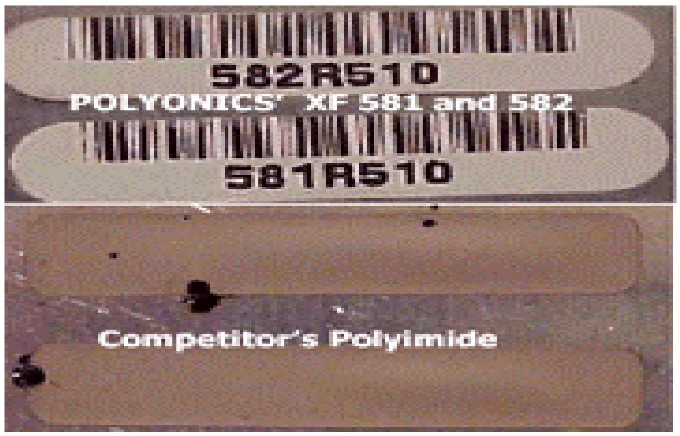


There is a correlation between price and performance-as the performance demands increase, so does the price. Although today a manufacturer might be using less expensive (hence less thermally resistant) labels quite satisfactorily, such as a polyester or polyetherimide. As the process's thermal environments shift to higher temperatures, the "cooler" spots become "less cool". Consequently, the manufacturer may have to change materials, with a subsequent increase in cost, as shown in the next figure.



Surprisingly, even if the manufacturer is already using polyimide labels today does not necessarily mean these labels will work in the new thermal environments. That is to say, " not all polyimide labels are created equal…. ". However, using polyimide labels today does not mean increase in cost upon switching to the newer generation of polyimide labels. These new materials, XF 581, 582, 583, and 584 are available today from Polyonics.

As the photograph shows the Polyonics X F five '81 and '82 clearly outperform of the polyimide materials of a very well-known competitor, when the labels were exposed side-by-side at **600 ° F (312 ° C) for 50 minutes.**



There's a second aspect of the new "lead free" initiativ, in that the labels themselves need to be clearly "lead free", that is, they can contain no heavy metals such as lead or chromium. Moreover, the new labels cannot contain chlorinated or brominated materials, commonly used as flame retardant additives in many plastic and adhesive materials. The table shown in Appendix I displays the analysis of Polyonics new generation THERMOGARD® label materials to be used for the lead free initiatives worldwide.

As the processes change, so will all of the process inputs such as chemical cleaners. Therefore, Polyonics has developed strategic relationships with leading cleaning companies: Kyzen, Zestron, Petroferm, and AlphaMetals. We are also working closely with the thermal transfer ribbon companies to ensure that the thermal ribbons used comply with the lead free initiatives, moreover Polyonics is actively testing its new lead free materials with electronic contract manufacturers and others so that the actual field test results will help us " stay ahead of the curve " as we develop cost-effective, the new generation materials.

For further information visit Polyonics web site at www.polyonics.com. Under the ***LINKS*** section www.polyonics.com/links/leadfreeinitiativewebsites.html for **Web sites targeted specifically at lead free initiatives.**

Appendix I.
Polyonics Heavy Metals and Lead Free Disclosure Statement

Environment Related substance		Use/Not Use
Heavy Metals	Cadmium and cadmium compounds	Not used
	Lead and lead compounds	Not used
	Mercury and mercury compounds	Not used
	Hexavalent chromium compounds	Not used
Chlorinated Organic Compounds	Polychlorinated biphenyls (PCB)	Not used
	Polychlorinated naphthalenes (PCN)	Not used
	Chlorinated paraffins (CP)	Not used
	Mirex (Perchlordecone)	Not used
	Other chlorinated organic compounds	Not used
Brominated Organic Compounds	Tetrabromobisphenol-A-bis-(2, 3-dibromopropylether) (TBBP-A-bis)	Not used
	Polybrominated diphenylethers (PBDE)	Not used
	Polybrominated biphenyls (PBB)	Not used
	Compounds	Not used
	Other brominated organic compounds	Not used
Organic tin compounds (Tributyl tin compounds, Triphenyl tin compounds)		Not used
Asbestos		Not used
Azo compounds		Not used
Formaldehyde		Not used
Polyvinyl chloride (PVC) and PVC blends		Not used