Selecting the Right Underfill to Minimize Solder Extrusions
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In today’s world of high-value devices, the capacity to rework such devices after underfilling so as to reduce scrap and maximize margins is essential. The ability to save time, equipment and labor are all components that must be factored in to the total cost of ownership equation, but equally important is rework speed and simplicity. Underfill reworkability – required either for device defects noted during manufacture or from field returns – is a key consideration.

The almost ubiquitous use of underfills to improve mechanical shock and thermal cycle performance of circuits means that their ease of reworking is a key performance criterion. An easy-to-rework underfill can save both time and money. Efforts to optimize the process have paralleled the development of more reworkable underfills which, together, make component removal and site clean-up easier, resulting in faster processing and less board damage. With the high density of today’s assemblies (component separations now being routinely below 200 µm), additional challenges have emerged for both the underfilling and rework processes. First, there is frequently “spillover” of underfill onto adjacent components, requiring the use of additional material. Second, during rework there can be thermal “spillover” with adjacent components experiencing temperatures above the liquidus of the solder used to attach them. The effect of this additional reflow cycle can cause molten solder to be squeezed either into voids in the underfill (resulting in a short) or completely out from under the component (resulting in and open joint). This process is referred to as solder extrusion. Although the phenomenon of solid state solder extrusion is well-known and has been studied in relation to flip chip thermal cycling, molten solder extrusion has not been as widely investigated in assembly-level rework operations.

Molten solder extrusion only occurs when an underfilled part is exposed to temperatures above the solder melt point and is characterized by spherical solder particles remote from the joint. This usually happens when an adjacent component or RF shield is removed for rework. Once a solder extrusion pathway is established to the edge of the component/underfill, the majority of the solder from the joint may be siphoned out, resulting in an open joint. As array devices are the most frequently underfilled components, solder extrusion is most often observed here but, because underfill can also spill over to adjacent components, there is the possibility that chip resistors and capacitors -- and even leaded components -- are also affected.

To better understand the propensity of some underfills to be more prone to solder extrusions (which some suggest occur more often with easily reworkable underfills as opposed to less-reworkable or traditional flip-chip underfills), Henkel technologists studied several materials. In this recent work, three capillary underfills were evaluated:

- A low CTE, High-Tg Flip Chip Underfill
- A low Tg Highly Reworkable Underfill
- An Improved Thermal Cycle Performance Reworkable Underfill
The study showed that the key parameter in determining solder extrusion was not Tg or CTE but adhesion. This decoupling of solder extrusion performance from CTE and Tg allows Henkel’s formulators to optimize these important properties for thermal cycle and mechanical shock, while maintaining reworkability. The underfill system, Loctite UF 3810, is unique among assembly-level underfills because of this combination of characteristics. And, according to the results of this testing, the characteristics of this underfill may have the ability to completely eliminate the problem of solder extrusions during rework. In comparison to the other evaluated materials, Loctite UF 3810 delivered the greatest amount of latitude when reworking components close or adjacent to those underfilled with this material. When components underfilled with Loctite UF 3810 were subjected to temperatures from RF shield removal, there was only a small chance of solder extrusion creation.

The avoidance of solder extrusion, while critically important, isn’t the only attribute of Loctite UF 3810. Ideally suited for today’s handheld communication and entertainment applications, Loctite UF 3810 delivers excellent drop and shock protection and improved thermal cycling reliability for fine-pitch, 0.3mm and 0.4mm area array devices. In addition to superior performance versus alternative reworkable underfills, Loctite UF 3810 also provides ease-of-use that lends to its process flexibility. The material flows fast at room temperature and cures quickly at moderate temperature which, in addition to its halogen-free status, adds to the material’s sustainability through reduced energy consumption requirements. These characteristics, in combination with its proven solder compatibility, make Loctite UF 3810 a highly versatile, yet highly effective, underfill system.

For more information on Loctite UF 3810 or to find out more about the referenced research regarding solder extrusions, contact The Electronics Group of Henkel at 1-888-943-6535 in the Americas, +32 1457 5611 in Europe or +86 21 3898 4800 in Asia, or log onto www.henkel.com/electronics.