Graping occurs when oxide forms on the outside of the printed paste deposit and the activators are not able to remove it. The smaller the deposit, the more surface area exposed to oxidation relative to total flux. Therefore, small deposits such as 0201's put a very high demand on the flux activator. Halogen-free materials will likely be more prone to graping.

Figure 4. Incomplete Coalescence (aka graping)

The second defect likely to become more common during the halogen-free transition is the head-in-pillow defect. Head-in-pillow happens during the reflow process when using a BGA component or PWB that is prone to warping. As the BGA or PWB warps, it creates separation between the ball and the solder paste deposit. At the reflow stage, both the solder paste and the ball go molten, but are not in contact with each other. An oxide layer will build up on the molten solder making it less likely to coalesce together when they come back into contact with one another during cool down. The resultant open solder joint will look like the illustration shown in Figure 5.

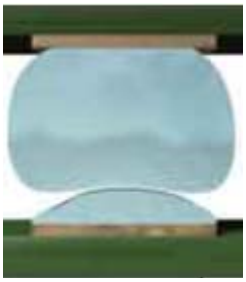

Figure 5. Head-in-Pillow Solder Joint

As a result of graping and head-in-pillow solder joints, solder paste manufacturers will have a challenge formulating halogen-free solder pastes that perform as well as the current halogen contained materials. Improving the reflow performance isn't that simple though. As the activator is modified it can adversely affect the print performance, stencil life, and shelf life. Therefore, when evaluating the halogen-free materials, it is essential to carefully examine the reflow performance, but don't skimp on the print portion of the evaluation.

**SUMMARY**

As the industry is moving toward promoting environmentally friendly, or "green," electronics, there continues to be a rapid minimization and/or elimination of halogenated compound use. This can have an adverse effect on material costs, product reliability, and process yields. Understanding the halogen-free material properties is key to successfully assembling more environmentally friendly electronics.

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