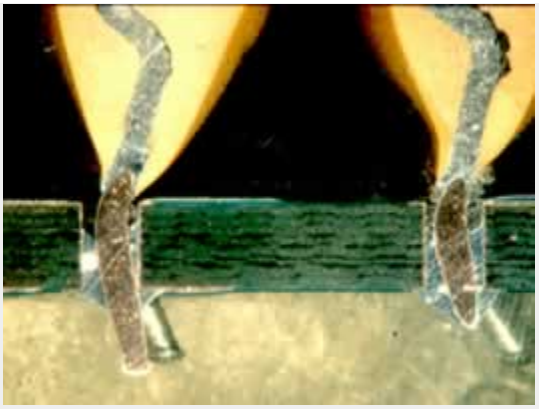
Holes and voids

Holes

Lack of hole fill, pin-holes in joints, and voids are important for the long-term reliability of products. Normally a plated through-hole should be filled with solder during soldering. If a hole is not filled there is cause for concern, because it may indicate a defect in the copper plating of the barrel. This kind of defect can fail during thermal stress testing.

Microsection of poor topside solder fillets



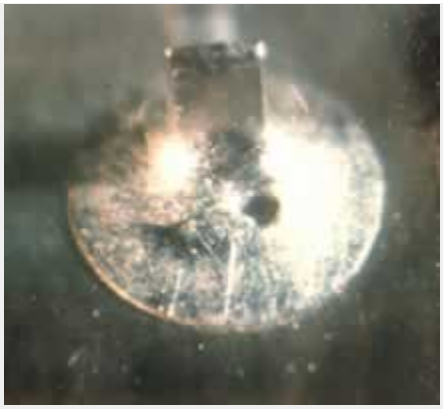
There are also concerns about unfilled through vias leading to reliability problems because of trapped process chemicals, leading to corrosion during use. The problem is particularly acute with high aspect ratio vias, which are difficult both to plate and to clean from process chemicals and flux.

Properly made joints don't have visible holes, but pin-holes and blow-holes occur frequently in solder joints, particularly those made by wave soldering. With through-hole components, where the joints are relatively large, there is probably little reliability hazard, although holes of this nature generally indicate poor control of the soldering processes[1]. The

general current view in the industry is that such defects are acceptable if you can see the bottom!

1. In the past, some military specifications required such joints to be reworked, but there is increasing acceptance of the fact that reworking a joint for cosmetic defects will degrade its reliability.

Pin-hole/blow-hole in solder joint



Voids

Potentially much more serious are the holes than one can't see, generally referred to as 'voids'. Both through-hole and surface mount processes suffer from voids, caused by gas bubbles that are released during the process of wetting of the surfaces to be joined and subsequent solidification of solder as the joint is cooled. These bubbles may come from the breakdown of fluxes, volatile residues from the fluxes, contamination on the surfaces being joined, and moisture or process chemicals[2] trapped in through-holes and vias.

2. According to work carried out by Cogg and Lea at NPL, the main causes of voids in a through-hole joint are moisture in the board laminate, poor quality of barrel copper plating, and poor adhesion

between barrel copper and laminate. Lea found that flux or process chemical entrapment did not result in the voids, as postulated by previous researchers.

Voids in surface mount solder joints are affected by the type of paste, the paste volume, joint geometry, solderability of materials and the reflow profile. Compared with wave soldering, surface mount solder joints are formed at lower temperatures, where the solder flows less well, and this increases the potential for voids. There is also a very much higher percentage of volatile components, which form an integral part of the solder paste and need to be removed during reflow. Inevitably there will be at least some small voids, although some researchers have reported reduced voiding when a nitrogen atmosphere is used.

The general belief is that a small volume of voids, uniformly dispersed throughout the joint, should have minimal impact on the integrity of that joint. However, there is corresponding concern that large voids, or excessive numbers of voids, might affect the mechanical[3] and thermal characteristics of the joint. They might also affect the ability of a joint to withstand low-cycle fatigue, on the basis that voids are similar to closed cracks in form, and should therefore act as stress-raisers.

3. Typically joints have such a low electrical resistance that even orders of magnitude change in joint resistance have no discernible effect on circuit function.

But what measurable impact do voids in through-hole joints have on reliability? Some evidence[4] suggests that fatigue life may in fact improve because the reduced amount of solder provides a compliant bridge between lead and barrel. On the other hand, very large voids (50% of the joint volume) can sometimes cause cracking

4. As a result, it is now recommended that joints with voids should not be reworked, provided that they are electrically continuous.

Voids are of particular concern with the small rigid joints associated with BGAs, where the solder ball itself is the joint. Banks studied the effect of voiding on BGA reliability, and reported that voids up to 24% of the volume caused no negative effect on reliability. In fact, joints with voids had 16% better reliability than those without voids. The cracks that occurred were in the same places whether or not the joints had voids.

The issue as to whether voids affect the reliability of solder joints is still under debate. Voids can be stress raisers; equally they may act as stress relievers and crack arresters. What is clear is that the size of the voids, their distribution, and their location are critically important. Typically we try to create joints which have at most small uniformly dispersed voids, and adjust the process to achieve this.

Source : http://www.ami.ac.uk/courses/topics/0155_holv/index.html