Hidden solder joints inspected non-destructively

Less space introduces new failure modes which cannot be inspected visually

Introduction

IC packaging technologies are becoming smaller and thinner. Ball grid array (BGA) packages were introduced some years ago in order to save space on the PCB, and are now widely used. To overcome the resulting problems with using optical microscopy as an inspection tool, the endoscope found its way into quality engineering departments.

QFN –difficult to inspect optically

One of the 'best sellers in today's packaging world is QFN - which has solder joints connected directly to pads on the rear of the package. With this package, there is practically no stand-off space, and inspection by optical microscopy is no longer possible.

BGA – difficult to inspect optically

This is also the case for many flip-chip assemblies. Furthermore, with the introduction of stiffer and brittle lead-free solder joints it is often necessary to underfill many BGAs to improve their mechanical robustness. This again restricts the optical inspection of solder joints.

High resolution real-time X-ray inspection can be used for non-destructive evaluation and documentation of solder-related issues such as shorting, missing solder joints, misalignments, insufficient paste, voiding, solder splash, and balling or wetting issues.

Furthermore, by tilting the viewing angle it is possible to check for solder joints that have not solidified properly (cold joints), using an oblique view.

Quality concerns – 4 case studies

Here are some brief pictorial case studies of how non-destructive X-ray inspection has been employed to support failure analysis or evaluation of assembly quality:

Case 1: Solder paste deposition problems with QFN assemblies
Case 2: Wetting issues on a special QFN package
Case 3: Interconnect failure with flip-chip packaging
Case 4: BGA assembly

For further information please contact:

Helle Rønsberg – hr@delta.dk
Yavuz Köse – yak@delta.dk
Daniel Bøjle – dab@delta.dk

DELTA
Venlighedsvej 4
2970 Hørsholm
Denmark
Tel. +45 72 19 40 40
asic@delta.dk
asic.madebydelta.com

Case 1: Solder paste deposition problems with QFN assemblies

This customer had purchased an assembled dual QFN package from a new subcontractor. When the board assemblies were received, various types of electrical failures were observed. X-ray inspection clearly pinpointed insufficient solder paste on some pads to be the problem (fig. 1), which may have been caused by too large a sphere size in the paste used. On some boards, solder splashing was also observed (fig. 2).

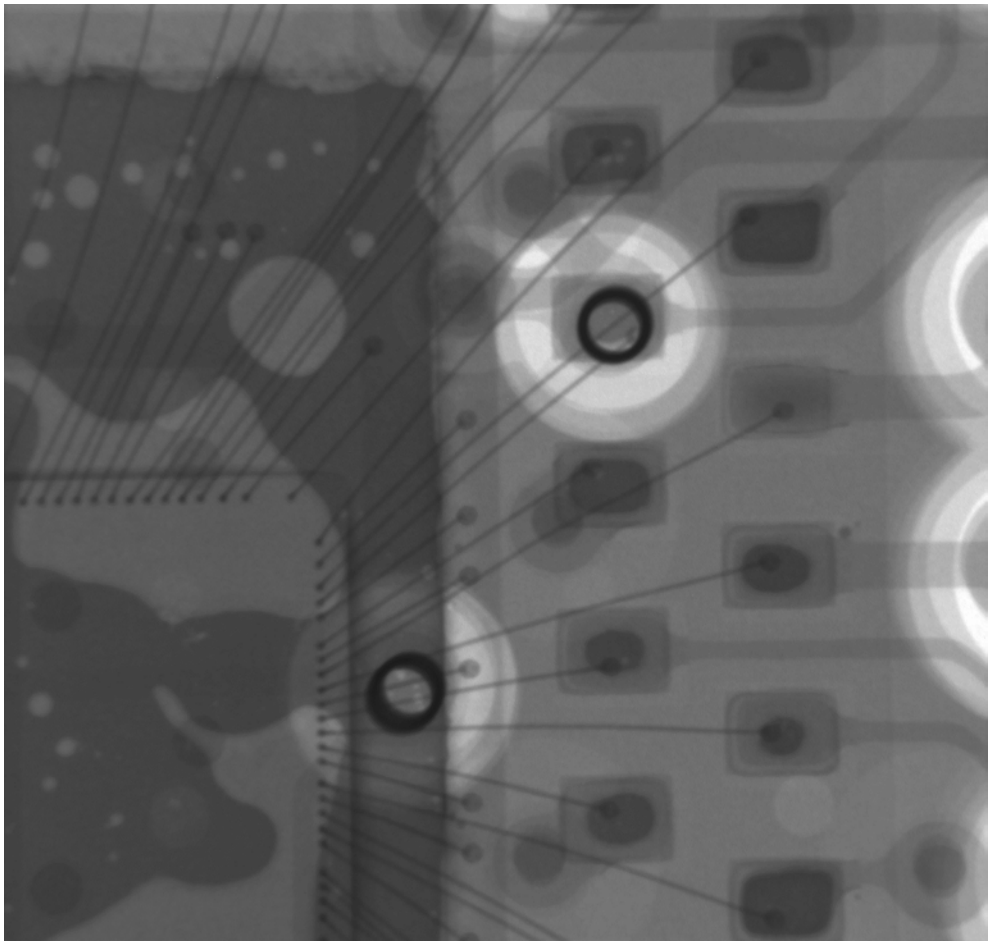

FIG. 1 X-ray micrograph showing a dual QFN package assembly. Missing or insufficient solder paste can be clearly seen on some pads. Excessive voiding is also visible on the soldering of the exposed pad in the middle of the package.

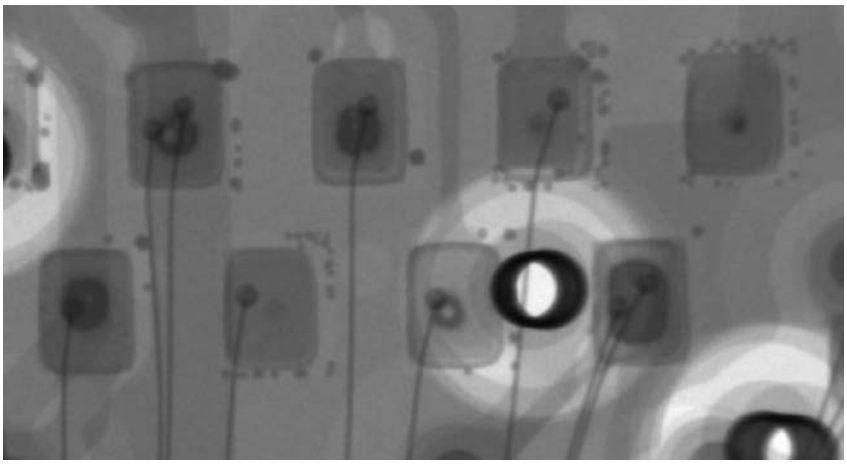

FIG. 2 X-ray micrograph showing an example of the solder splashing.

Case 2: Wetting issues on a special QFN package

This customer assembled some prototypes of a special QFN package for the first time. X-ray inspection was commissioned to evaluate whether the assembled prototypes could be delivered to the end customer. It was found that in general, the solder paste amount was insufficient and varying, and for some connections this resulted in component pad non-wetting (fig. 3).

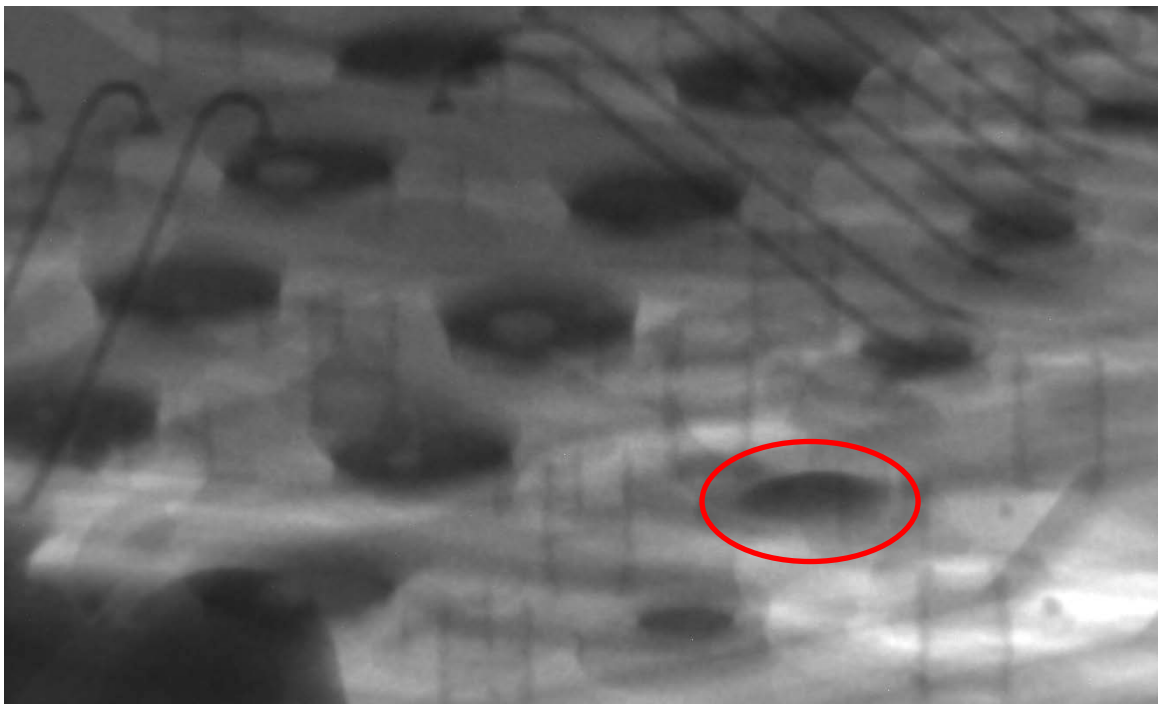

FIG. 3 View showing component pad non-wetting caused by insufficient solder paste.

Case 3: Interconnect failure with flip-chip packaging

DELTA offers stud ball bumping (SBB) flip-chip assembly of prototypes. On one project, subsequent electrical testing indicated an open joint. X-ray inspection pinpointed a bump with a possible missing connection. Cross-sectioning of an IC sample then performed for further analysis of the problem. It found that the root cause was due to poor planarity in the die-placement and pre-curing process (fig. 4).

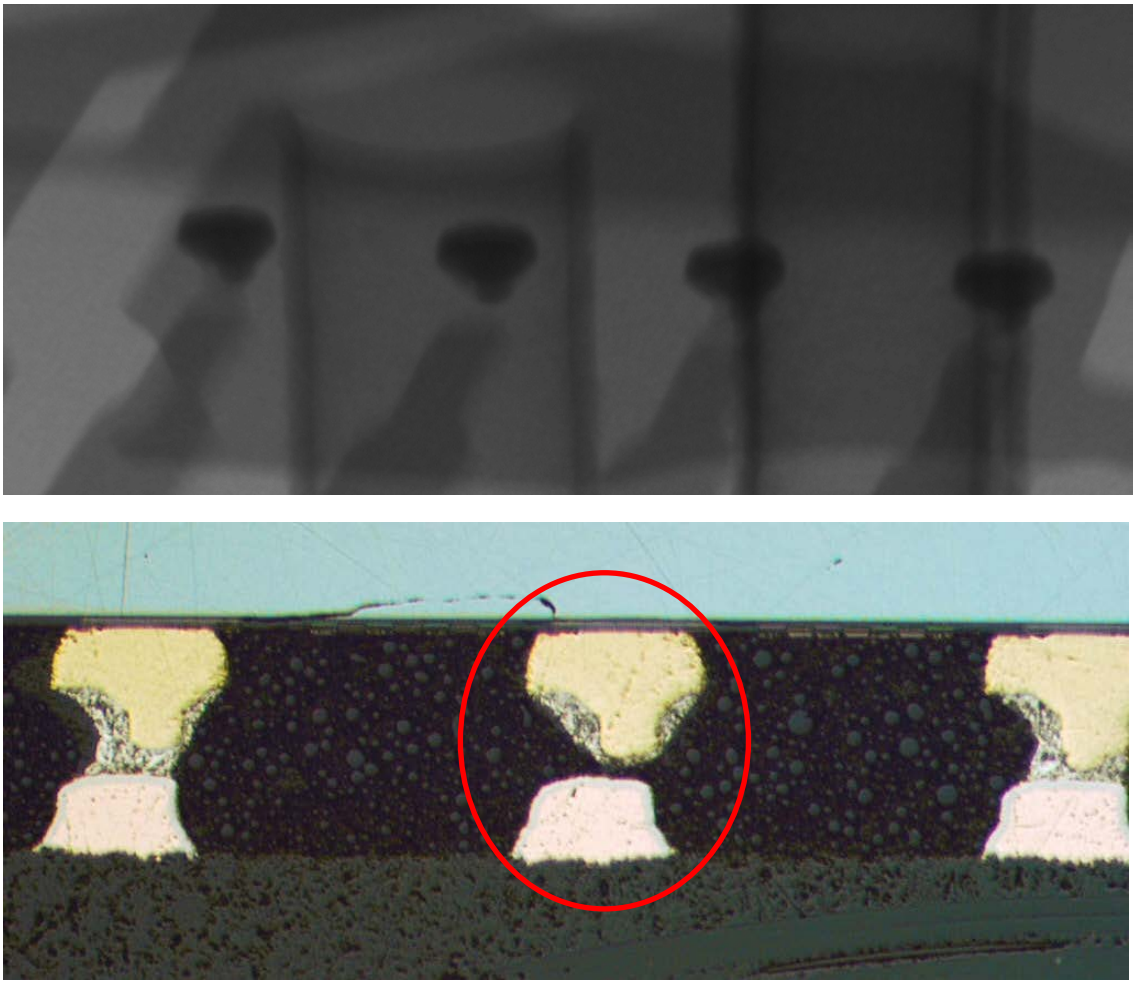

FIG. 4 Views showing the open flip-chip interconnect as seen by X-ray inspection (top) and optical visual inspection of a cross-section.

Case 4: BGA assembly

During printed circuit board assembly the yield was found to be inconsistent. X-ray examination was performed as part of the project's standard quality control procedures. From time to time, solder was seen to have moved from the BGA joint position towards vias located in the centre of four similar joints - see the typical X-ray view (fig. 5). Destructive Physical Analyses (DPA) demonstrated a problem with vias acting as solder 'thieves' in the BGA, due to poor coverage of the solder resist coating on some lots (fig. 6)

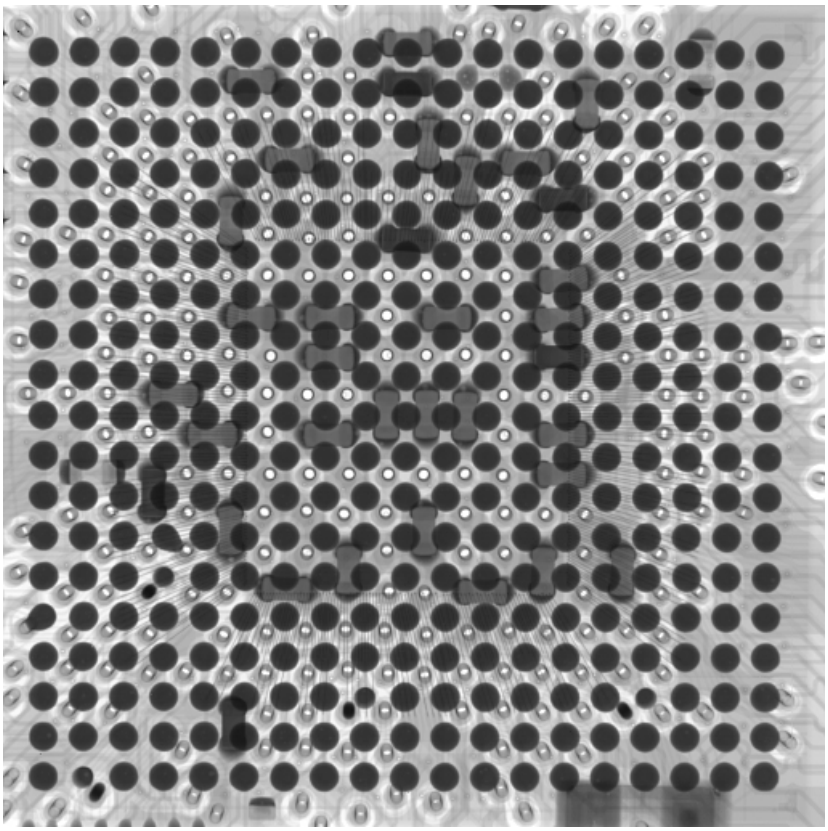

FIG. 5 X-ray view of the BGA solder joints. Notice the tendency to solder movement away from the intended joints and towards vias.

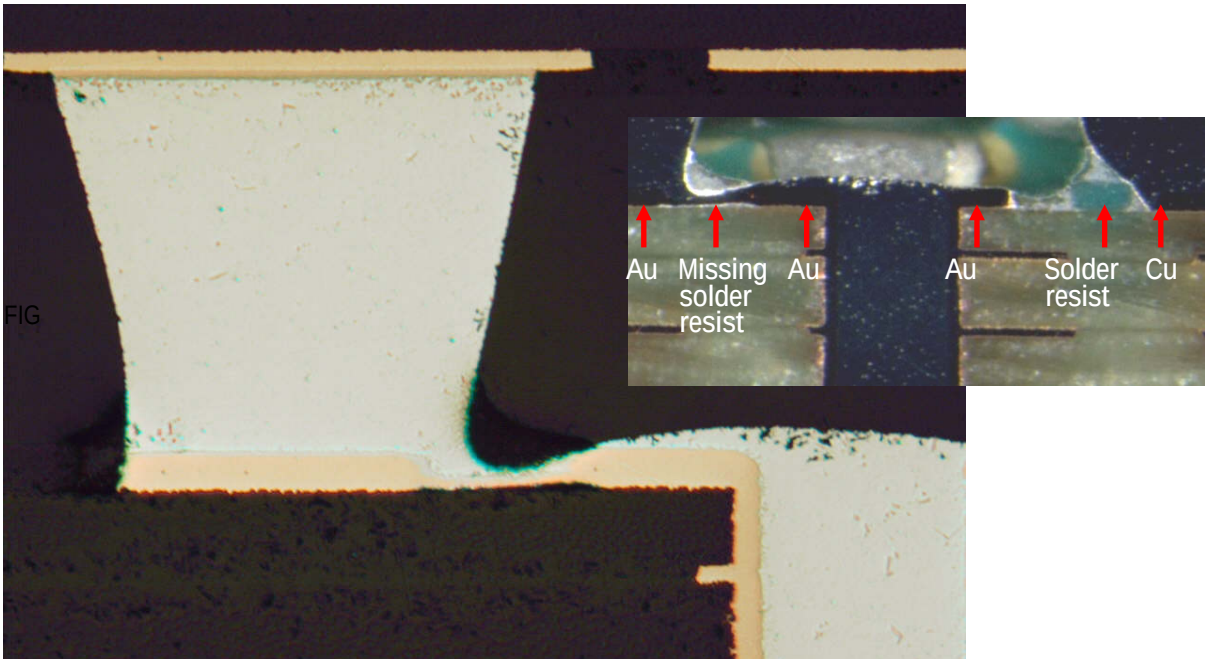

FIG. 6 Optical view of a device cross section at the position pinpointed by X-ray examination. Notice the via acting as a solder 'thief', caused by missing solder resist.