Flip chip inspection

As flip chip packages continue to move into mainstream production, they bring their own specific problems in terms of inspection and test. One solution uses sound to find defects. Seems simple enough. Flip the chip over and connect its active side by solder bumps. This increases performance and saves space because you don't need bond wires. These advantages are making flip chips an increasingly popular package on modern boards. Yet the flip chip design has a fundamental drawback: by placing the chip face down, its interconnects become hard to inspect.

Solder bump bonds, the solder bumps themselves, and the underfill which is usually present are all sites for potential problems. A solder bump can be partly or entirely disbonded and underfill can be delaminated from a surface or contain voids. These defects, however, possess a common characteristic in that they consist of an air-filled discontinuity (or gap) in the material.

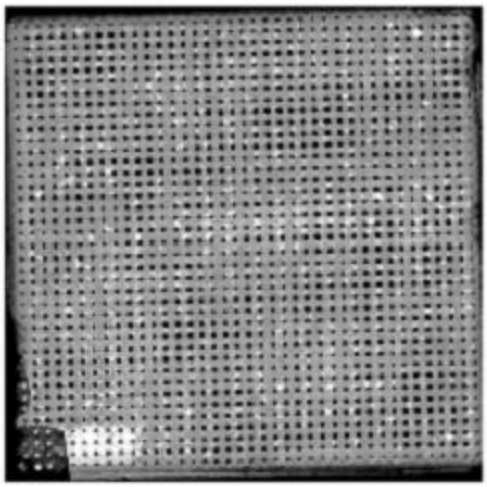
Fortunately for inspection purposes, such air-gap defects are the domain of an ultrasound-based technology from the medical world called acoustic micro-imaging. This can be employed to inspect a flip chip package using a transducer pulsing high frequency ultrasound into the package, and receiving the return echoes a few microseconds later. The ultrasound's round trip is executed a speeds ranging from 3000 to 9000m/s. Normal interfaces (a good solder bump bond, for example) reflect enough of the ultrasound to permit imaging. But an air gap a disbond, delamination, void or crack-reflects all of the ultrasound. In the corresponding acoustic image display this makes defects highly visible.

Because echoes from various levels within the flip chip package arrive back at the transducer at slightly different times, electronic gating can be used to restrict the acoustic image to specific levels within the package-for example, only the interface at which the solder bumps are bonded to the die face. In fact, this fine gating and high resolution is why acoustic micro-imaging is so useful for evaluating flip chips.

As acoustic frequencies increase, lateral resolution increases, while penetration ability drops off. But flip chip packages have tiny internal features, and so require a high frequency with good penetration ability.

Flip chip images

Fig. a : flip chip investigation,
"balls" are clearly visible,
the white areas show defects like
air inclusions.



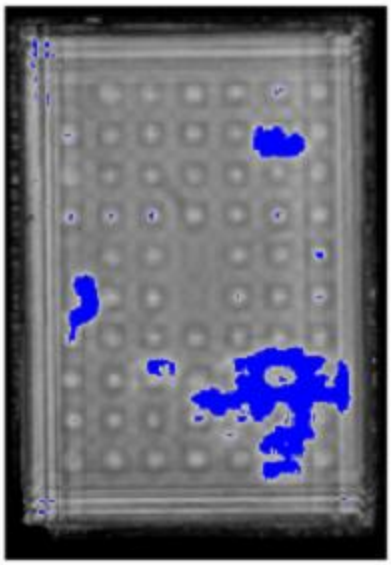


Fig. b : flip chip investigation,
delamination in blue, 30µm solder bumps are visible

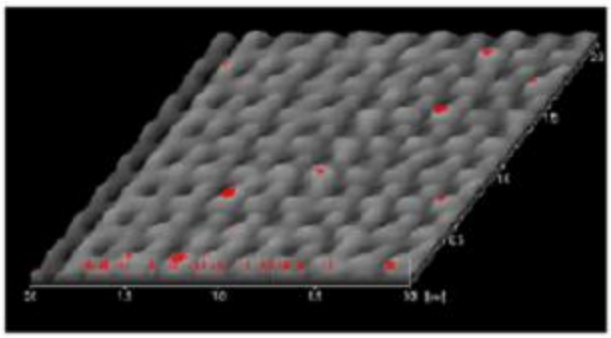


Fig. c : flip chip investigation,
3D image, defects colored in red

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