Case Study 3

X-ray reveals wire bonding and field failures

An essential tool in initial stages of non-destructive IC failure analysis

**Introduction**

Wire bonding is widely used for first-level interconnection of semiconductor die to component leads or pads.

It is vital that the interconnection corresponds to the product-specific bonding diagram and that the wire bonding is of an acceptable robustness and quality.

**Gold wires**

Wire bonds are typically made from 18–25 micron diameter gold or aluminium wire. Gold wires can be visualised very effectively by non-destructive X-ray imaging. X-ray examination can easily identify major wire bonding quality issues such as wire sweep, sagging, touching, tailing, breakage and ball lift. This makes it possible to examine IC products for packaging related irregularities, weaknesses and catastrophic failure modes - all without introducing failures.

**X-ray used as step 1 for failure analysis**

X-ray examination is an essential tool during the initial stages of IC failure analysis. Devices from new component lots are compared to a reference device. In this way it is possible to determine and document if a certain product complies with the specification. Furthermore, various device degradations like shorts, breakage and/or melted wires can be revealed.

X-ray examination is also valuable as a post-qualification testing analytical tool, to identify and document issues such as wire breakage degradation caused by accelerated temperature cycling testing.

**X-ray views - Examples**

The illustrations below show just how clearly X-ray documentation is able to identify binding-related IC quality issues and field failure modes.

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**FIG. 1** X-ray view - an example of a failure caused by wire sweep. The standard maximum for sweep is 10%.

**FIG. 2** X-ray examination of a stitch wire breakage.
FIG. 3  X-ray view of wire breakage and ball lifting issues.

FIG. 4  An enlargement of the lifted ball.
FIG. 5  X-ray view showing melted-down wires.

FIG. 6  Higher-magnification view of one of the melted wires.
FIG. 7  The wire connecting the device to power is totally evaporated, and the ball on the connection to output has also melted down.

FIG. 8  Enlargement of the melted ball.

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