

Summary of copper: ·
lower cost · strong



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SummaryThe purpose of this report is to review the reliability issues between gold wire and copper wire in thermosonic ball bonding. By comparing the advantage and disadvantage of both gold wire and copper wire to see if copper wire can be used to fully replace gold wire in thermosonic ball bonding. Introduction (Russell Tobias, May 2015) In IC packages, thermosonic bonding is widely used to create electrical connections between the die pad and lead frame. These interconnect are made using a combination of lower heat and pressure with ultrasonic energy, as shown in the diagram.

Thermosonic Bonding: (Hybond, 2018) Is a process which uses force, time, ultrasonic and heat to create electrical connection from the contact pad to the lead frame. The wire is pressed against the hot surface with a low force and ultrasonic force that vibrated for a period of time to achieve the bond.

There are two types of wires use in thermos-sonic ball bonding: Gold Wire Bonding: (Hybond, 2018) Firstly, a ball or sphere is formed on the end of the contact pad with an EFO (Electronic Flame Off). The flame-off was done with an open hydrogen flame which would rotate towards the end of the wire and melt it, creating a ball at the end of the wire. (Small Precision Tools) Copper Wire Bonding: The copper wire bonding process is very similar with gold wire bonding as it basically uses the same wire bonder equipment with minor hardware and software retrofits.

Instead of gold wire, it is replaced by copper wire. (Small Precision Tools) Copper wire bonding offers significant advantages over gold – superior product performance in terms of electrical and thermal conductivity; better product reliability due to slower intermetallic growth that causes voids; and

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higher break load during wire pull testing. Advantage &

Disadvantage Advantage of copper: · Lower cost · Strong

mechanical properties · Excellent ball neck strength · Better Heat

distribution · Increase power ratings with thinner wire diameters ·

Lower resistivity · Very little void formation in the Al-Cu system ·

Can be bonded on bare Cu substrates Disadvantage of copper: · Cu is

harder than both Al and Au, risk of damaging the underlying pad and

dielectrics · Easy to be oxidised in air, requires additional processing

tools or coating to prevent oxidation. · (Z. W. Zhong, 2009) Poor bond

ability for stitch/wedge bonds · Additional bonding parameters for using

forming inert gas Copper VS Gold As shown in the table as compared to Gold,

Copper has a better reliability as compared to Gold. Since Cu wires conduct

heat faster and better than Au, they allow for a shorter heat-affected zone

(HAZ).

As very high currents and temperatures are reached during electronic flame-

off (EFO) firing, the heat generated during free air ball (FAB) formation will

promote grain growth along the wire. It is well known that grain growth is

undesirable for wire bond reliability. Conclusion (Z. W.

Zhong, 2009) In conclusion, I personally think that using copper wire as the

material for thermosonic ball bonding is a good option. As the rising cost of

Gold, better mechanical and electrical properties, and better interfacial

reliability of Copper with Aluminium pads are the primary reasons for the

transition from Gold to Copper. As mention previously copper wire have

many advantages as compared to wire bonding using gold wire.

Even though there is disadvantage, which brings many new challenges to wire bonding. Companies just need to deal with the challenges and solve the problems in copper wire bonding in order to fully benefit from its many advantages Reference Russell Tobias, May 2015, Joining Methods in Electronics Packaging: Sintered Silver and Eutectic Bonding, https://www.researchgate.net/figure/282330752_fig1_Figure-12-Thermosonic-gold-ball-wire-bonding-schematic. Z. W. Zhong, 2009, Wire bonding using copper wire, <http://www.ntu.edu.sg/home/mzwzhong/Wire%20bonding%20using%20copper%20wire.pdf>

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