

Copper to the  
increasing price of  
gold,



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Copper Wire Bonding | CPAT Research Assignment      Name: Tay Ling Rong

Annabel Student ID: S10166225K Class: P3V2 For many years, Thermosonic ball bonding with gold (Au) wire has been the most widely acknowledged and commonly used in many industries.

Due to the increasing price of gold, copper wire is used to replace gold wire in Thermosonic ball bonding. This report will give an elaboration on the advantages and disadvantages of using gold and copper wire in Thermosonic ball bonding. Wire bonding is the process of making electrical connections between the contact area of the circuit and the external leads by using very fine wires. The wires used are usually made of Gold (Au) and Aluminum (Al), while Copper (Cu) is just starting to gain footing in the semiconductor manufacturing industry. Gold Wire Bonding Gold wire bonding has been the most trustworthy and stable interconnect solution since its development about 50 years ago, however the demand for cheaper costs, smaller outline packaging, accelerated and improved device performance, longer battery life has led to engineers looking at flip chip ball bump connections as an alternative to wire bonding. The conductivity of Au is the best amongst the other types of solder.

Au has the best electrical conductivity compared to any other solder with an increase in thermal conductivity. For example, Au has an electrical resistivity of  $2.19 \mu\Omega\text{-cm}$ , while lead and its alloys has an electrical resistivity of  $22 \mu\Omega\text{-cm}$ .

The process of making gold wirebonds: A spark or small flame is used to melt the tip of the gold wire so as to form a spherical ball which is about twice the diameter of the wire.

The ball is then thermosonically welded to a metallised pad on the semiconductor. A loop of wire is formed as the bonding capillary moves across to the contact pad of the device package. The wire is thermosonically welded to the metallised pad of the package. The sharp edge on the tool is used to cut the wire, therefore leaving a length protruding to form the next ball.

Advantages of Gold Wire Bonding 1. Good oxidation resistance 2. High-electrical conductivity 3. No bonding parameter required 4. Specifically refined to high purity (99.99% Au) 5. Widely used around the world

Disadvantage of Gold Wire Bonding 1.

Uneconomical as it is very costly 2. Low electrical and thermal properties 3. Low mechanical stability 4. Greater intermetallic growths

Copper Wire Bonding Copper wire bonding is the process where the wire bonding process uses Copper (Cu) wires for interconnection. Over the years, Copper has been a popular material to use in the semiconductor industry because of its many benefits as compared to Gold (Au).

One obvious reason that Copper is chosen over Gold is the cost. Copper is 3 to 10 times cheaper than Gold, therefore many companies and industries have already switched to using Copper as their main material for interconnection. This can help companies save in their production cost and in turn, increase their annual revenues. Other than the cost of the material, Copper wire are actually 25% more conductive as compared to Gold, which is very important for the development of high performance and efficiency devices despite using small diameter copper wire to fit small

Advantages of Copper Wire Bonding

1. 90% cost reduction
2. Good electrical and thermal conductivity
3. High mechanical stability
4. Lesser intermetallic growths

Disadvantages of Copper Wire Bonding

1. Oxidation at low temperatures
2. Requires a bonding parameter due to its hardness
3. Comparatively new, therefore Copper wire bonding technology is not as well understood as Gold wire bonding technology

Summary of the advantages and disadvantages of Copper wires over Gold wires

In conclusion, Copper wire bonding has more advantages over gold wire bonding. However, since it is still a relatively new technology, there are bound to have some obstacles that need to be overcome. Therefore, in order to choose which material to use, it is important to consider the bonding application and synthetic costs to make the perfect choice.

Reference

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