BONDING WIRE SIZES AND SELECTION

ADVANCED TECHNOLOGY FOR RESEARCH & INDUSTRY

KNOWLEDGE BASE FACT SHEET

- SCOPE: What considerations are needed to be taken into account when selecting a wire for wirebonding?

There are many factors that need to go into consideration when selecting and specifying which bonding wire is needed for any given application. These could be the metrological specification of the chosen material, the dimensions of the bond pads, or the packaging and spooling requirements.

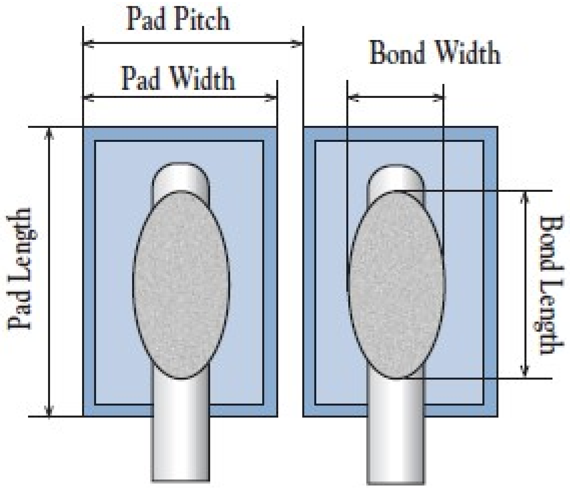
When considering a bond wire, the following key points need to be known:

- **Material Type**
- **Purity**
- **Wire Diameter**
- **Elongation & Tensile Strength**
- **Spool Size**

Wire Diameter:

Generally bonding wires can range from 12.5 - 500µm in diameter. The 12.5 - 75µm range is generally considered to be a **fine** wire application, and the 100 - 500µm range is for **large or heavy** wire applications. Wire diameter is usually determined by the circuit (such as current-carrying capability and frequency required) or component requirements and tolerances (such as bond pad size, pitch and length).

Wire pad size, position and pitch will greatly affect the constraints of the maximum wire diameter that can be used. The greater the outside wire diameter the larger the bonding tool will need to be, the larger the tool the more clearance is needed between bonds, directly affecting the minimum pitch size that can be bonded. Other factors that will need to be considered are the fusing current, electrical resistance, thermal conductivity and active impedance for high frequency applications.



Material:
Bonding wires are manufactured from the highest purity materials and precisely doped and annealed to give the desired grain structure and mechanical requirements. Bonding wires are produced from metals that have a good electrical conductivity such as gold, aluminium and copper. Driving factors for material selection usually come from process and performance requirements as well as cost.

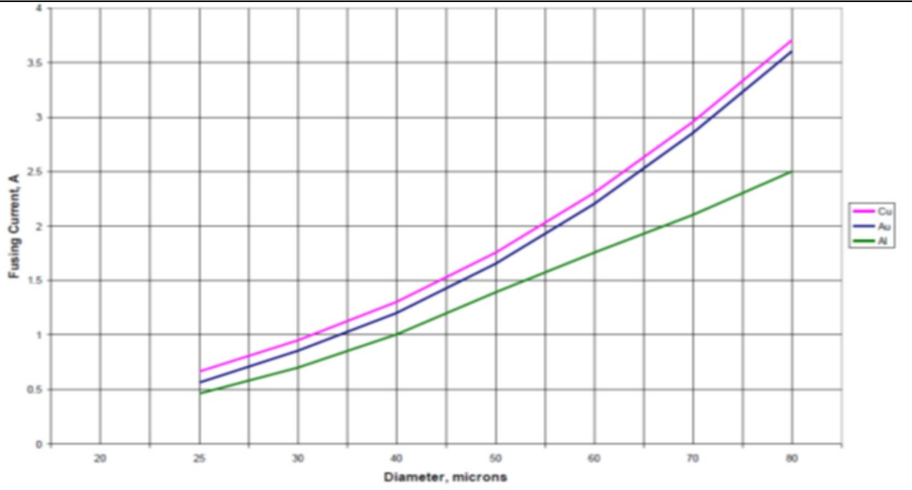
Aluminium bonding wire for heavy wire (100 - 500µm) applications and ribbon generally has a purity of either 99.99% or 99.999%. Fine wire (17 - 75µm) aluminium is an alloyed wire, containing 1% silicon (1%SiAl) in order to help prevent silicon migration from a bonded semiconductor die, which could result in a deterioration in bond quality and durability, as well as shaping improvements for the bond loop.

Gold bonding wire for fine wire (12.5 - 75µm) applications is made from 99.99% pure gold with doping additives to facilitate very high speed automatic processing, and is a very homogeneous composition.

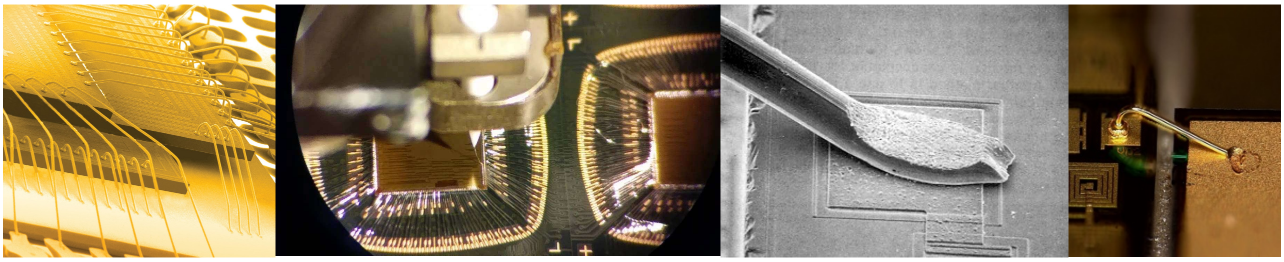
Other materials can be used and found in wirebonding for specific applications, examples of which are copper, silver, platinum, palladium, and some coated wires.

Composition	Diameter		Tensile Strength (gms)	Elongation (%)
99.99% Au	0.7 mil	17.5 µm	3 - 10	2 – 6
	0.8 mil	20 µm	4 - 13	2 – 7
	0.9 mil	22.5 µm	5 - 16	2 – 8
	1.0 mil	25 µm	6 - 20	2 – 8
	1.3 mil	32.5 µm	10 - 45	2 – 10
	1.5 mil	37.5 µm	13 – 50	2 - 12
	1.7 mil	42.5 µm	15 – 60	2 - 12
	1.8 mil	45 µm	20 – 70	2 – 12
	2.0 mil	50 µm	25 – 85	2 – 15
	3.0 mil	75 µm	50 – 180	2 – 20

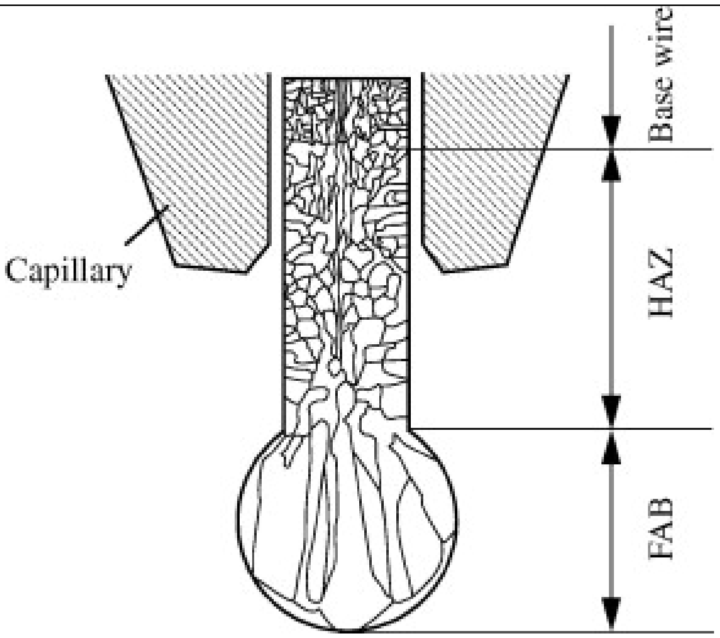
Composition	Diameter		Tensile Strength (gm)	Elongation (%)
99.999% Aluminum	5 mil	125µm	60 min.	2 – 6
	8 mil	200µm	100 min.	5 – 15
	10 mil	250µm	180 min.	10 – 18
	12 mil	300µm	325 min.	10 – 20
	15 mil	375µm	400 min.	10 – 25
	20 mil	500µm	700 min	15 – 35



Tensile Strength & Elongation:
The physical properties of the wire such as elongation and tensile strength differ when specifying a bonding wire for different wire bonding processes. The specification of a 25µm gold wire for a thermosonic ball bond is different from that needed to make a thermosonic wedge bond. As the looping profiles on a ball bond will be usually higher compared to a wedge bond, then having a wire that is stable at higher loops is more critical in your wire selection - the higher and more stable the wire is at looping could mean a compromise in strength and / or reliability. The 25µm gold wire that has been thermosonic wedge bonded will usually have lower loops that need to be stable and have lower impedance for high frequencies applications. The wire will be doped, annealed and tooled to suit these characteristics. Each desired criteria of the wire will affect the bonding performance in some way so research into the wire's datasheet is essential.



Grain Structure:
Grain structure can affect the properties of the wire bond being made, especially in a gold ball bond. During the ball formation (EFO), the properties of the wire directly above the FAB (free air ball) are altered. The HAZ (heat affected zone) is mechanically weaker than the original wire, so this directly affects the loop formation and stability. A fine grain structure introduces a shorter HAZ providing lower loop heights. A long HAZ assists in loop shapes that are naturally higher without relying on the capillary trajectory.



Spool Size:
There are two main considerations to take into account when specifying what spooling requirements you need for your bonding wire. The first is the spool type itself, which needs to be compatible with the wire bonding system you are working with. As the wires are subject to contamination which can affect bond quality and strength, as well as the fine nature of the wire, reworking or re-spooling the wire is not recommended, making the spool specification more critical.

The second criterion to take into account is the length of the wire you require on the spool as well as how many layers are wound on the spool. Multi-wound spools that have more than one layer of wire wound onto the spool will hold an increased length of wire, but this increases the risk of wire becoming snagged from the spool as it is fed into the wirebonding machine. Fine wire SiAl is more prone to becoming snagged if oxide layers start to form from incorrect storage. This is especially true for small bobbin-like spools that have multiple wires, as this wire tends to have “memory” so it will try to return to the wound shape if left unused on the machine for too long.

For manual wirebonding machines it is recommended to use a single wound layer to prevent this. If using a fully automatic wirebonder, then changing wire spools means additional down time which will affect production and throughput each time a machine is stopped for a spool change, so a multi-wound spool may be more desirable.