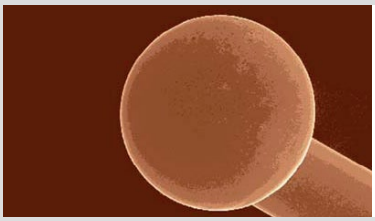
Heraeus

DHF & iCu
Copper Bonding Wire for Power Devices & High-End ICs



DHF & iCu Copper Wire Benefits

- Mechanical and electrical properties comparable to, or better than, gold and aluminum wire.
- Wire cost saving up to 90%
- Excellent conductivity and reduced heat generation allow thinner diameters.
- Slower intermetallic growth results in lower electrical resistance and increased reliability.
- Availability in diameters as thin as 0.6 mil, or in excess of 4.0 mils, allows use in a wide range of applications.

Copper Wire... A Viable Alternative to Gold

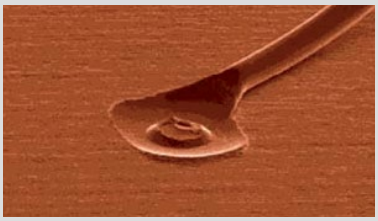
Recent studies have shown that, in many applications, copper wire bonding can provide better performance and reliability than gold wire bonding. While copper wire has been used in discrete and power devices for many years, these latest studies also show that successes in ball bonding thin copper wire to aluminum, silver-nickel plating and even bare copper, provide the potential for its use in high-end, fine-pitch packages with higher lead counts and smaller pad sizes. For these reasons, along with the lower inherent cost of copper material, Kulicke & Soffa Bonding Wire has developed and optimized two copper wire products: DHF copper wire for ball and wedge bonds in power and discrete devices, and iCu for fine-pitch or high-end IC applications.

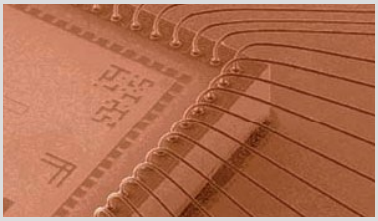
Reduced Intermetallic Growth... Higher Reliability

Tests show that, after exposure at various temperatures, intermetallic growth is significantly slower in copper wire bonds than in gold wire bonds. This results in lower electrical resistance, lower heat generation and, ultimately, increased bond reliability and device performance. Tests also show that despite a lower amount of intermetallic penetration, pull force and shear testing show values that are equivalent to, or greater than, those obtained with gold wire.

Excellent Mechanical and Electrical Characteristics

Tempered and annealed iCu copper wire exhibits higher tensile strength and elongation than gold wire, resulting in better ball neck strength, reduced wire sag and excellent loop stability during encapsulation. Because copper exhibits better conductivity than gold, DHF wire allows for increased device power ratings and also accounts for better heat dissipation in packages.





Recommended Technical Data of DHF

Diameter	**Microns (µm)**	38	45	50	63	75
	Mils	1.5	1.8	2.0	2.5	3.0
Elongation	**(%)**	10 – 20	12 – 22	15 – 25	15 – 30	15 – 30
Breaking Load	**(g)**	20 – 35	30 – 45	40 – 55	60 – 90	80 – 120

Recommended Technical Data of iCu

Diameter	**Microns (µm)**	15	18	20	23	25	28	30	33
	Mils	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
Elongation	**(%)**	7 – 15	8 – 15	8 – 16	8 – 16	8 – 16	10 – 20	10 – 20	10 – 20
Breaking Load	**(g)**	3 – 6	4 – 8	5 – 10	6 – 12	8 – 15	10 – 20	12 – 22	15 – 25

For other diameters, please contact Heraeus Bonding Wires sales representative.

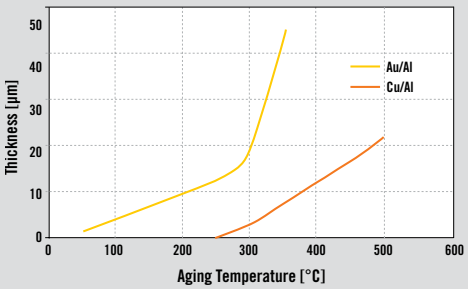
Wire Specifications

Chemical Composition	
Copper	99.99%

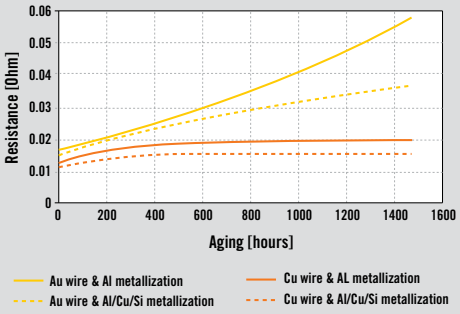
Physical Properties	
Density	8.92 g/cm^3
Melting Point	1083 °C
Thermal Conductivity	401 W/m.K
Specific Heat Capacity @ 25 °C	385 J/kg.K
Coeff. of Thermal Expansion	16.5 µm/m °C, (20 – 100 °C)
Electrical Resistivity	1.69 µΩ/cm
FAB Hardness (120 mA EFO)	100 – 110 HV (0.02 N/5 s) (DHF)
	90 – 100 HV (0.01 N/5 s) (iCu)
Elastic Modulus	60 – 90 GPa (DHF)
	110 – 140 GPa (iCu)

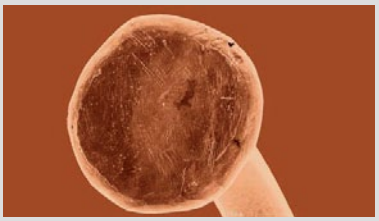
Other Guidelines	
Floor Life	7 days
Shelf Life Time	6 months
Recommended Shielding Gas	Forming Gas
Bonding Temperature	200 – 240°C

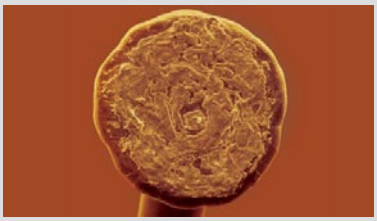
Intermetallic Phase Growth t = 5 hrs



Electrical Resistance after Aging (at 175°C)







The SEM photographs above show evidence that the intermetallic penetration of the copper ball bond (above left) is significantly less than in the gold ball bond (above right). While this may raise questions as to the integrity of the bond, mid-span pull force tests show an average value of 44.6 grams (3.2 gr Sigma) and shear strength values of 6.5 gr/mil^2; values that are, at least, comparable to those obtained with gold wire.

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