

Copper Wirebonding

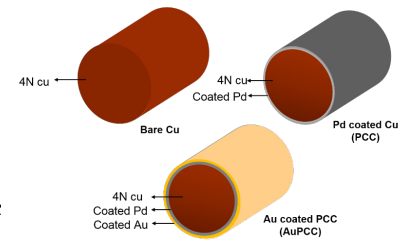
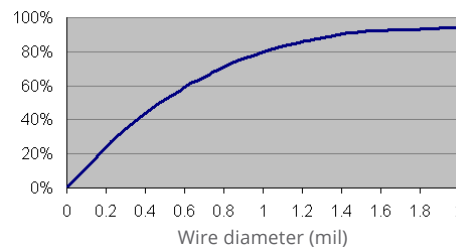
Cu wire offers significant cost advantage over Au wire. It is also an excellent replacement for Au wire due to its similar electrical properties. Self-inductance and self-capacitance are nearly the same for Au and Cu wire and Cu wire has lower resistivity. In applications where resistance due to bond wire can negatively impact circuit performance, using Cu wire can offer improvement.

COPPER WIRE BENEFITS

Cu wire has long been used as a method of connecting a silicon die to the package terminals. With the recent increase in gold (Au) wire cost, Cu wire is an attractive way to manage overall package cost.

- ▶ Increasing cost of Au is driving the need to use lower cost Cu wire
- ▶ Copper is an attractive replacement material for Au because of good electrical & thermal performance
- ▶ Amkor has a long & wide history of Cu wire process
 - ▷ 20+ years of experience (development to HVM)
 - ▷ Qualified on 0.6-2.0 mils diameter Cu wire
 - ▷ Under development: >2.0 mils diameter Cu wire
- ▶ Mass production on both leadframe & laminate products
- ▶ Cu wire is supported in all Amkor worldwide factories with mass production since 2006
- ▶ Amkor worldwide Cu wire BOM/BKMs established

Wire Material Cost Savings Cu Versus Au



Cu-Alloy Wire Readiness

| Package Family | Cu Wire HVM Plant |
|--------------------------|-------------------|
| CABGA | C3, K4, P3, ATJ |
| fcCSP | C3 |
| LQFP | P1, ATJ |
| MicroLeadFrame® (QFN) | C3, P1, P3 |
| MQFP | P1, T1 |
| PBGA | K4, P3 |
| PDIP, PLCC | P1 |
| Package-on-Package (PoP) | K4 |
| PSOP | P1 |
| SBGA | K4 |
| SC70 | P1 |
| SCSP | C3, K4, ATJ |
| System in Package (SiP) | K4 |
| SOIC | P1 |
| SO8-FL | M1 |
| SOT-23 | P1 |
| SSOP | P1 |
| TQFP | P1, ATJ |
| TSSOP | P1 |
| TSON, TOLL | M1 |

Copper Wirebonding

| Wire Dia (μm) | Current Carrying Capacity (Amps) | | | | 3D Electrical Parasitic Parameters | | | | | |
|---------------------------------------|----------------------------------|--------------------|--------------------|--------------------|------------------------------------|---------|----------|---------|----------|---------|
| | Wire Length >40 mil (1 mm) | | | | Wire Length = 40 mil (1 mm) | | | | | |
| | Wire Type | | | | R11 (m Ω) @ 1 GHz | | C11 (pF) | | L11 (nH) | |
| | Au Wire (4-9's) | Au Wire (3-9's) | Au Wire (2-9's) | Cu Wire (4-9's) | Au Wire | Cu Wire | Au Wire | Cu Wire | Au Wire | Cu Wire |
| 51 | 1.83 | 1.81 | 1.61 | 1.83 | 73.9 | 62.2 | 0.119 | 0.119 | 0.515 | 0.515 |
| 25 | 0.63 | 0.62 | 0.55 | 0.63 | 144.4 | 116 | 0.081 | 0.081 | 0.69 | 0.677 |
| 23 | 0.56 | 0.55 | 0.49 | 0.56 | 154.1 | 128.7 | 0.078 | 0.078 | 0.707 | 0.687 |
| 20 | 0.45 | 0.45 | 0.4 | 0.45 | 172.9 | 145 | 0.075 | 0.075 | 0.728 | 0.724 |
| 18 | 0.39 | 0.38 | 0.34 | 0.39 | 196.3 | 163.2 | 0.071 | 0.071 | 0.76 | 0.751 |
| 15 | 0.29 | 0.29 | 0.26 | 0.29 | 234.3 | 194.7 | 0.067 | 0.067 | 0.811 | 0.801 |
| Resistivity ($\mu\text{ohm-cm}$) | 2.3 | 2.5 | 3 | 1.7 | | | | | | |

Minimum Bond Pad Size by Wire Diameter (T = Bond Pad Metal Thickness)

| | | 0.7 \leq T \leq 1.5 μm | | | | 1.5 \leq T \leq 2.5 μm | | | | 2.6 \leq T \leq 4.0 μm | | | |
|------------------|------------------|---------------------------------------|------------|------------|------------|---------------------------------------|------------|------------|------------|---------------------------------------|------------|------------|------------|
| | | FWD | | SSB | | FWD | | SSB | | FWD | | SSB | |
| | | BPO | BPP | BPO | BPP | BPO | BPP | BPO | BPP | BPO | BPP | BPO | BPP |
| Recommended Wire | 15 μm | ≥ 40 | ≥ 48 | ≥ 42 | ≥ 50 | ≥ 42 | ≥ 50 | ≥ 44 | ≥ 52 | ≥ 44 | ≥ 52 | ≥ 46 | ≥ 54 |
| | 18 μm | ≥ 45 | ≥ 53 | ≥ 47 | ≥ 55 | ≥ 47 | ≥ 55 | ≥ 49 | ≥ 57 | ≥ 49 | ≥ 57 | ≥ 51 | ≥ 59 |
| | 20 μm | ≥ 50 | ≥ 58 | ≥ 52 | ≥ 60 | ≥ 52 | ≥ 60 | ≥ 54 | ≥ 62 | ≥ 54 | ≥ 62 | ≥ 56 | ≥ 64 |
| | 23 μm | ≥ 58 | ≥ 66 | ≥ 60 | ≥ 68 | ≥ 60 | ≥ 68 | ≥ 62 | ≥ 70 | ≥ 62 | ≥ 70 | ≥ 64 | ≥ 72 |
| | 25 μm | ≥ 62 | ≥ 70 | ≥ 64 | ≥ 72 | ≥ 64 | ≥ 72 | ≥ 66 | ≥ 74 | ≥ 66 | ≥ 74 | ≥ 68 | ≥ 76 |
| | 30 μm | ≥ 79 | ≥ 87 | ≥ 81 | ≥ 89 | ≥ 81 | ≥ 89 | ≥ 83 | ≥ 91 | ≥ 83 | ≥ 91 | ≥ 85 | ≥ 93 |
| | 33 μm | ≥ 85 | ≥ 93 | ≥ 87 | ≥ 95 | ≥ 87 | ≥ 95 | ≥ 89 | ≥ 97 | ≥ 89 | ≥ 97 | ≥ 91 | ≥ 99 |
| | 38 μm | ≥ 105 | ≥ 113 | ≥ 107 | ≥ 115 | ≥ 107 | ≥ 115 | ≥ 109 | ≥ 117 | ≥ 109 | ≥ 117 | ≥ 111 | ≥ 119 |
| | 51 μm | ≥ 150 | ≥ 158 | ≥ 152 | ≥ 160 | ≥ 152 | ≥ 160 | ≥ 154 | ≥ 162 | ≥ 154 | ≥ 162 | ≥ 156 | ≥ 164 |

Minimum Bond Pad Size by Wire Diameter (T = Bond Pad Metal Thickness)

| | >60 nm | 55/60 nm | 45/40 nm | 28 nm | <28 nm |
|--------------------|--------------------|--------------------|--------------------|--------------------|-------------|
| Non-Low-k Or Low-k | Low-k | Low-k | Ultra Low-k | Ultra Low-k | Ultra Low-k |
| Reliability Status | Customer Qualified | Customer Qualified | Customer Qualified | Customer Qualified | In Process |
| Production Status | HVM | HVM | HVM | HVM | Development |

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