

Silver Wirebonding

A huge increase in the price of gold (Au) has driven the need for lower cost wire materials. Bare copper, Palladium-Coated Copper (PCC), Au-coated PCC (Au PCC) and silver (Ag) alloy wires have emerged as alternatives to gold bond wires. Copper-based wires are low cost and have excellent electrical resistivity. However, the hardness of copper makes it difficult to use in many applications such as those with fragile bond pad structures. For these applications, Ag-Alloy offers properties similar to those of gold while its cost is similar to that of Au PCC.

AMKOR OVERVIEW

Amkor entered volume manufacturing in 2013. Five package families (laminates/leadframe) are in volume production with >50 other packages under qualification and evaluation.

KEY FEATURES

- ▶ Ag-Alloy wire is softer than Cu wire resulting in lower Al-Splash and lower risk of bond pad damage
- ▶ Ag-Alloy wire has a wide process window that improves manufacturability for devices with fragile bond pad structures

BENEFITS

Ag-Alloy wire is the best low-cost replacement for applications that need:

- ▶ Die-to-die bonding, waterfall bonding and very thin Al pad
- ▶ Ultra-fine bond pad pitch (BPP) and small bond pad openings (BPO) with less Al splash
- ▶ Ultra-low loop height
- ▶ Ag alloy has higher resistivity than Au and PCC

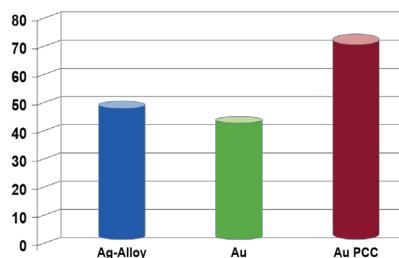


Package Families Using Ag-Alloy Wire Devices

CABGA	PSOP
LQFP	SC70
MicroLeadFrame® (QFN)	SCSP
MQFP	SOIC
PBGA	SOT-23
PDIP	SSOP
PLCC	TQFP
fcCSP	TSSOP

Note: Contact Amkor for detailed production and development status of specific package families

Free Air Ball (FAB) Hardness (Hv)



Ag-Alloy Wire Readiness

	In Production	In Development
Process Nodes	14 nm	<14 nm
Wire Diameter	18 μm	15 μm
Inline Bond Pad Pitch	40 μm	35 μm
Staggered Bond Pad Pitch	25/50 μm	20/40 μm
Standoff Stitch Bonding Pad Pitch	50 μm	40 μm

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Ag-Alloy Wire Readiness

	Ag-Alloy	Au	Au PCC	Impact
Wire Cost	Lower Cost	Expensive	Lowest Cost	Au PCC And Ag-Alloy Wires Are Significantly Cheaper Than Au Wire
FAB Hardness	Soft	Soft	Hard	Harder Materials Cause Cratering, Bond Pad Crack
Process Windows (Force, Power, Time)	Wide	Wide	Narrow	Wider Process Window Improves Manufacturability For Devices With Fragile Bond Pad Structures
Al Splash	Minimal	Minimal	More	Less Aluminum Splash Is Better For Fine Pitch And Small BPO
Ultra-low Loop Capability	Excellent	Excellent	Limited	Ultra-low Loop Capability Allows Thinner Packages
Resistivity	Good	Better	Best	Lower Resistivity Is Better For High Current Carrying Applications

Properties of Different Wire Materials

		Ag-Alloy	Au	Au PCC
Physical Properties				
Hardness (Hv)	Free Air Ball (EFO = 120 mA)	50-60	44-49	70-80
	HAZ	50-60	44-49	55-65
	Wire	60-70	49-55	60-70
HAZ Length (µm)		60-80	60-80	80-100
Density (g/cm ²)		10.58	19.2	8.98
Elastic Modulus (Gpa)		60-70	80-90	90-100
Recrystallization Temp. (°C)		500-550	500-550	500-550
Melting Point (°C)		980-1010	1060-1080	1080-1100
Fusing Current (A, Length = 10 mm)		0.44	0.47	0.58
Resistivity (uΩ cm) @ 20°C		3.3	2.9	1.9
Thermal Conductivity (W/mk)		429	317	401
Coefficient Of Thermal Expansion (0 ~ 100°C, ×10-6/K)		19	14	17
Elongation (%)		2-12	2-7	3-17
Material Composition				
Purity (%)		>95%	>99%	99.98

Note: Numbers in the table above are based on wire diameter of 0.8 mil

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