Compatible Metallization with Electrically Conductive Silver Epoxies

WHAT

Compatible Metallization
for Silver Epoxies

WHY

Considerations for PCB & circuit assembly
when choosing ECAs ahead of solder joining

Why Silver Epoxies?

Silver epoxy adhesives (ECAs) have been widely used in semiconductor and electronic packaging industries since the 1960s, as a reliable connection method instead of soldering or eutectic joining of metals.

After 2000, as a result of the global transition to lead-free electronics, the majority of the electronic component manufacturers are now using pure tin or tin-rich alloys for soldering, SMD terminals and leaded devices. This change has resulted in increased reflow temperature, less ductility and more likelihood of "tin-whisker" formation. It is well known that electrical shorts caused by growth of these tin whiskers (needle-like metal crystals) have knocked out guided missiles and communication satellites, caused heart pacemakers to fail and watches to stop ticking.

These concerns have catapulted silver epoxy (ECA) applications. While the ECAs have advantages over tin rich soldering processes, what they adhere to needs to be chosen carefully. When used for electrical contact, it is important that the metallization has similar potentials to avoid galvanic corrosion and non-conductive oxides.

What is a "Tin Whisker"?

A tin whisker is a conductive tin crystal, which can spontaneously grow from tin based lead-free finished surfaces even at room temperature, often in a needle-like form. Oxidation in humid conditions, corrosion, intermetallic formation, stress under thermal cycling, and electromigration have all been shown to promote whisker formation.

While pure tin has gained the most notoriety for developing whiskers, these pesky crystalline filaments can also grow from other metals, including cadmium, silver, and zinc.

Metal & Metal-Oxides

Palladium, platinum and gold are noble metals which will not readily oxidize, due to their electron orbital configuration. Silver is also a noble metal with a similar configuration, but will oxidize under the right conditions. However, even if the silver is oxidized, its oxides are conductive.

Lead and tin are main group metals containing free electrons that will readily form non-conductive oxides and can cause serious conductivity issues. Since these oxides form on the surface of the metal, they can also significantly reduce the shear strength of an adhesive bond.

Ag, Sn, Al Joints

Silver epoxy should never be used on pre-tinned surfaces for three reasons.

- It is industry legacy and common sense that noble metals like to be joined to other noble metals.

- Silver and tin have dissimilar potentials, leading to galvanic corrosion, via a tarnish or rusting process.

- Silver itself can be a catalyst for tin whisker formation.

Manufacturers should avoid pure tin altogether by plating components with materials that do not have a tendency to whisker, such as Au, Ag, AgPd, NiPdAu, Pt, Pd, Cu.

Aluminum presents a similar quandary as tin, not producing whiskers, but its likelihood to readily oxidize. Aluminum oxide is an electrical insulator and mechanically it will yield a weaker bond than its non-oxidized form resulting in as much as a 50% difference in lap shear strength.

Compatibility Chart

Market	Sector	Compatible Metals	Comments	Compatibility
Semiconductor	wafers	Pd, Ni/Pd/Au	Al plated I/O's must be re-metallized
	Lead-frame	Ag, Alloy 42, Ag die paddles only	Avoid Sn plated lead frame & Cu die paddles
Hybrid Micro-Electronics	Die attach (d/a)	Au	Au plated ceramic substrates, Au backed chips
	SMD attach	Au, Ag, AgPd	SMDs can not be Sn/Pb plated
	EMI/Rf shield	Brass, SST, Kovar	Ohmic contact for grounding purposes
Electronics Assembly	Acoustics	Au, Cu	Pads on PCBs
		PZT, or similar	Piezo electric materials
	PCB level	Au, Cu	Never use Sn/Pb or SnAgCu solder pads
	RFIDs	Ag, Au	Contact pads on substrates
		PTF-Ag ink	Antennae coils for RF
	SMD caps	Au, Ag, AgPd	Cannot be SnAgCu or Sn/Pb terminations
	Tantalum caps	Au	Industry standard terminations
	Solar cell	SnO, ZnO	Transparent Conductive Oxides - TCO
		Al/Cu, Cu/Sn, Cu/Ag	Ribbon wires
		Mo, Ag, Ni, Cr, TCOs	PV subtrates
Medical Device	Pacemaker	Au/Ceramic	Substrates packaged in hybrid form-factor
	Catheters	Pt/Ir	Guide wires, fluoroscopy
Opto-electronics	Fiber optics	Brass, SST, Kovar	Metal housings, EMI shielding
		Au/ceramic	Opto-circuit, or optical bench
		Lithium niobate	Die attach optical chips
	Sensor optics	SST, brass	EMI shielding
	Camera optics	Au	Common interconnections
	X-ray optics	Au plated scintillator	Electrical bridge to photo-detector arrays
	LEDs	Cu, Ag spot lead frame	Die attach LED chips, single chip package
		Cu, Au	LED arrays onto PCB, Cu heat sink
	LCD / OLED	ITO	TCO layer
		Au, Cu	Electrical bridge to PCB/substrate

Silver Epoxy ECA +'s

- *Is compatible with Si, GaAs, In, P and MEMs chips*
- *Can withstand 260°C lead-free reflow*
- *Are well matched with Au, Ag, Ag-Pd terminations of capacitors and resistor SMDs*
- *Will bond well to Pt, Pd, Au, Ag, Ni & Cu surfaces*
- *Provide an excellent alternative to solder joining*
- *Yields similar thermal conductivity values as most solder joints*

Silver Epoxy ECA -'s

- *Is not compatible with Sn, Al, and SnAgCu solder surfaces*
- *Should not be used with solder dipped pads on SMDs / PCBs*
- *In its cured form, can not be ribbon or wire bonded and will not accept solder joints*
- *Should have oxides removed from Cu and Ni surfaces prior to bonding*

REACH COMPLIANCE

RoHS COMPLIANT

MIL STD 883/5011 COMPLIANT

ISO 9001 COMPLIANT

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