

General Flip Chip Die Bonding Processes

HENRY CHOU

Besi Die Handling

Tel: (603)206-4828

hchou@besidiehandling.com

General Flip Chip Bonding Die Processes

ABSTRACT:

General overview of flip chip bonding techniques and bonding processes associated with flip chip and die attach. Bonding techniques include two methods, non-contact bonding and contact bonding. Bonding process include five die attach, process categories that are broken down further into specific applications.

TYPES OF BONDING PROCESSES

- Cold Compression
- Thermocompression
- Adhesive
- Solder Reflow
- Ultrasonic/Thermosonic

COLD COMPRESSION

- High Force at Ambient Temperature (Up to 200 kg)
- Focal Plane Arrays/Detectors/Sensors
- Indium bumps – very small down to 8x8x8 um bumps
- General rule of thumb => 0.1g / 10um square bump
- Crucial parameters – co-planarity, high force, accuracy

THERMO-COMPRESSSION

1. Metal Diffusion

- Temperature with Force
- Au to Au fusion (not reflow)

2. Adhesive

- Hold with heat cure
- Conductive or Non Conductive
- ACP/ACF adhesive

3. Reflow

- Ramp and Cool temperature with pressure
- AuSn, InSn Reflow

THERMO-COMPRESSSION

Metal Diffusion

- RF Devices
- Au to Au Diffusion
- Low resistivity/Strong bond
- General Rule of Thumb – 1g / 10um square bump
- Crucial parameters – high force, high temp
- Disadvantages – relatively slow process, high temp

ADHESIVE

- Conductive
 - Isotropic – conductive in all axis (ie. Ag paste)
 - Anisotropic – conductive in one axis (ie. paste or film)
- Non-conductive
 - UV or Heat Cure
- COF, COB, COG, Die bonding, Underfill
- Semiconductor and optoelectronic applications
- LCD, Biomed, VCSELS, MEMS
- Critical parameters – Precise dispensing, Dipping, Stamping, Screening

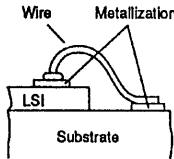
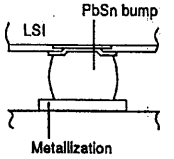
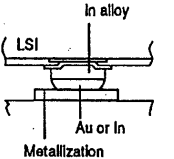
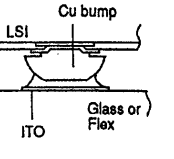
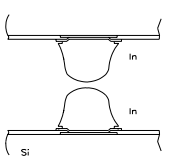
SOLDER REFLOW

- Any material that can be liquified and then solidified
- PbSn (Flux), AuSn, AgSn, InSn, In
- TWO METHODS:
 1. **Contact or Insitu Reflow:** Hold, reflow, and release (Non Self Centering Characteristics) – AuSn, InSn, In
 2. **Non-Contact or Batch Reflow:** Place, release, and reflow (Typically but not limited to Self Centering Characteristics) - PbSn, AgSn, and even AuSn
- Critical parameters – Upper/Lower heat, Force maintenance
- Reflow under gas environment ie. N_2 , H_2N_2
 - Gas Cover/Chamber for non-contact reflow
 - Gas Purge for contact or insitu reflow

ULTRASONIC/THERMOSONIC

- High frequency scrubbing
- Same method for wire/ball bonding
- Not too accurate ± 5 to 10 microns
- Parts cannot withstand high temp, low I/O count
- Critical parameters – small dies, lower accuracy, lower heated chuck (thermosonic)

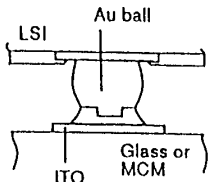
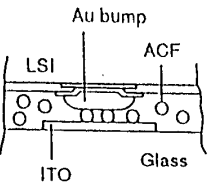
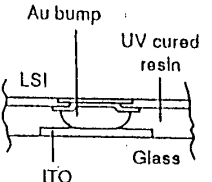
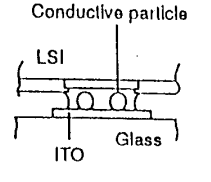
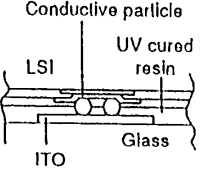
TYPICAL INTERCONNECT METHODS

Method	Wire Bonding	Flip Chip	Low Melting / High Melting		Solder Paste	Cold Bond
						
Interconnect	Au or Al wire	Solder	In alloy	Au Alloy	Conductive paste	In
LSI Electrode	Al pad	Pb/Sn bump	Au/In bump		Cu/Au bump	In
Conductor on Substrate	Au, Al	Au, Cu, Ni, or W	Al, Au, or ITO		ITO, Cu, or Au	Insp, HgCdTe
Bump Pitch	Min. 150µm	200 - 300µm	20 - 150µm		150 - 200µm	20 - 50µm
Bonding Temperature	150°C	300 - 350°C	ambient - 150°C	315°C	80 - 120°C	Cold 25°C or up to 80°C
Bonding Pressure	---	---	20 g/pad		1 - 2 g/pad	.1 - .5 g /bump
Other	---	---	---		---	---
Repairability	OK	good*	good*		good*	None
Benefits	<ul style="list-style-type: none"> • Uses current equipment • No bumps 	<ul style="list-style-type: none"> • Testable IC • Reflowable bumps 	<ul style="list-style-type: none"> • Low Temp Bonding • Reliable at Liquid nitrogen temperatures 		<ul style="list-style-type: none"> • Low cost • Low pressure bond 	<ul style="list-style-type: none"> • Clean • High IO • Reliable
Drawbacks	<ul style="list-style-type: none"> • Peripheral pads only • Low yield for high I/Os 	<ul style="list-style-type: none"> • High Temp Connection • Solder fatigue • Multiphase Underfill 	<ul style="list-style-type: none"> • Indium bumps are difficult to form 		<ul style="list-style-type: none"> • Gross pitch • Low control of paste spread 	<ul style="list-style-type: none"> • Extra Fine Pitch • High force required • Very accurate bonding equipment

* Repairability is poor after underfill encapsulation

Source: TechSearch International, Inc.

TYPICAL INTERCONNECT METHODS (CONTINUED)

Method	Ball Bumps	Anisotropic Conductive Film, Adhesive, Paste	Micro Bump Bonding - UV Resin	Conductive Particle	Conductive Particle UV Resing
					
Interconnect	Conductive paste/Thermo compression	ACF	Resin	conductive bump	conductive particle
LSI Electrode	Au ball on Al pad	Au Bump	Au Bump	Al pad	Au pattern
Conductor on substrate	ITO, Cu, or Au	ITO	ITO	ITO	ITO
Bump Pitch	60 – 130 μm	150 – 200 μm	50 μm	60 – 130 μm	50 – 300 μm
Bonding Temperature	100 - 200°C	160 - 180°C	room temperature	150 - 200°C	room temperature
Bonding Pressure	1 - 2g/pad	20 - 50g/pad	10 - 20g/pad	10 - 20g/pad	---
Other	---	---	UV light	---	UV light
Repairability	good*	difficult	difficult	difficult	difficult
Benefits	<ul style="list-style-type: none"> • Flexible bumping method • low capital 	<ul style="list-style-type: none"> • Easy application • No underfill required 	<ul style="list-style-type: none"> • low cost 	<ul style="list-style-type: none"> • no bumps required 	---
Drawbacks	<ul style="list-style-type: none"> • one at a time bumping • Need underfill 	<ul style="list-style-type: none"> • connecting resolution is low • More exp bonders 	<ul style="list-style-type: none"> • Not very reliable 	<ul style="list-style-type: none"> • unreliable connection with Al 	---

*Repairability is poor after underfill encapsulation

Source: TechSearch International, Inc.

Presentation by: **Henry Chou** – Product Manager - RD AUTOMATION Brand Flip Chip Die Bonders BESIE DIE HANDLING

10th Annual International KGD Packaging and Test Workshop