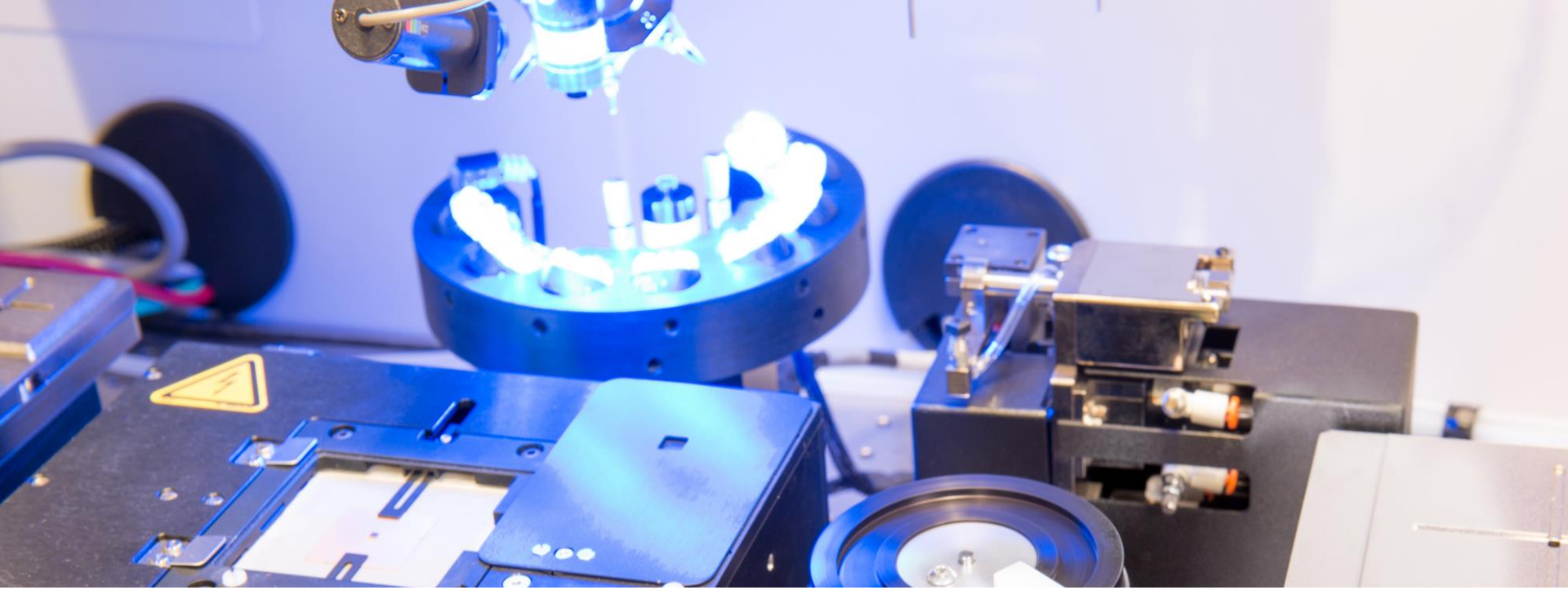

Introduction to Automated Flip Chip Assembly

Advantages, Component Performance/Reliability and Design Flexibility

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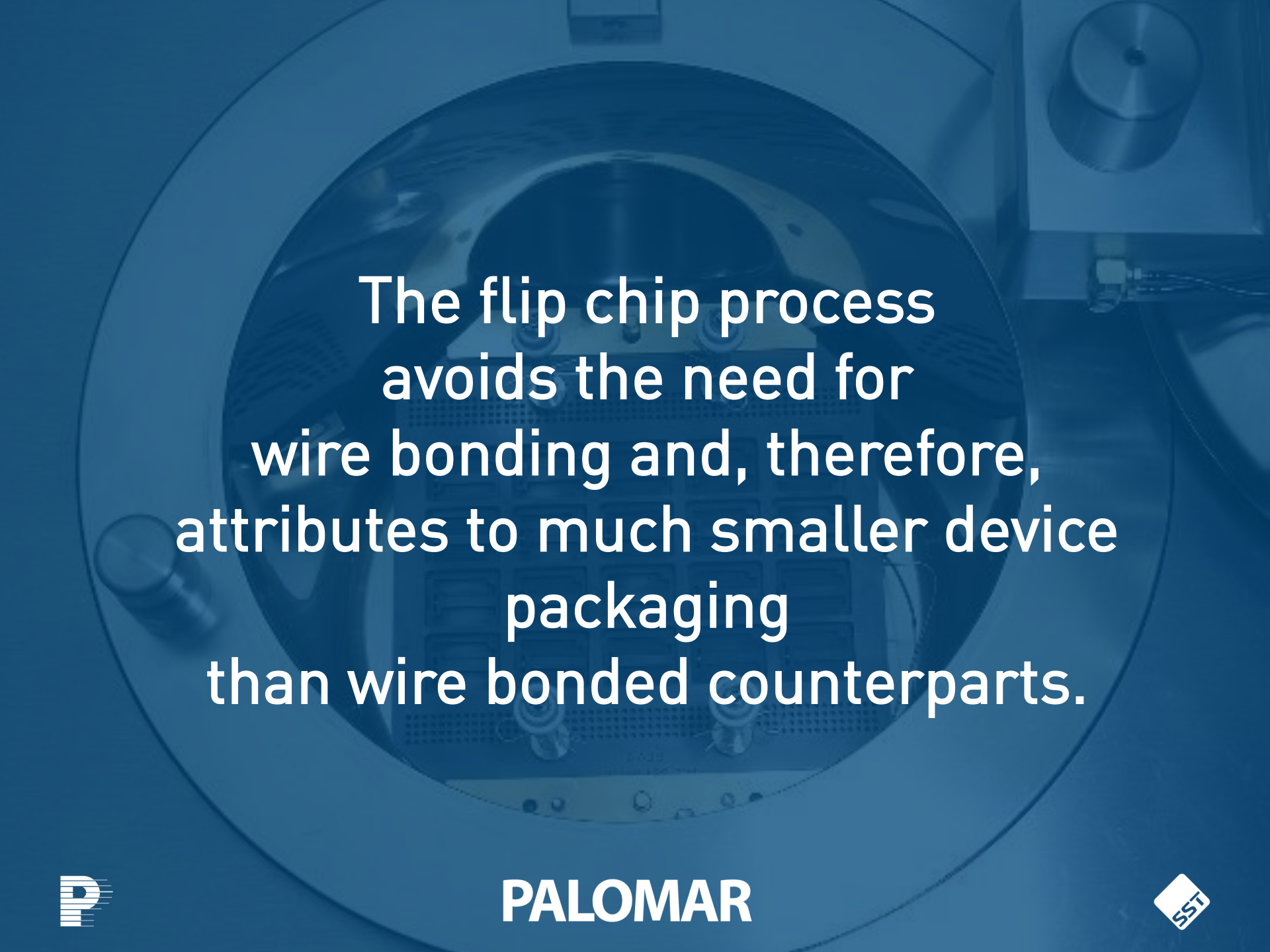


The flip chip process
avoids the need for
wire bonding and, therefore,
attributes to much smaller device
packaging
than wire bonded counterparts.

INTRODUCTION TO FLIP CHIP

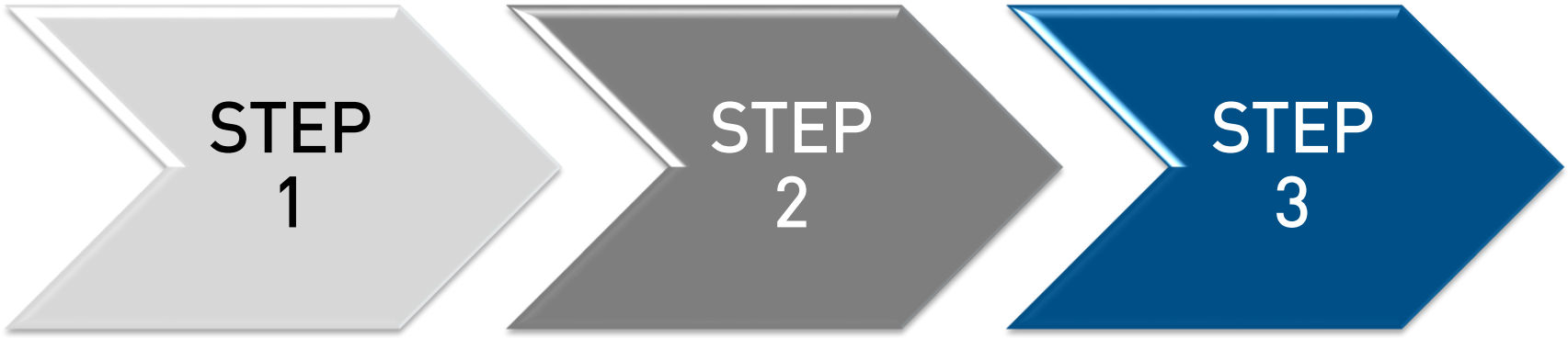
Flip chip is a method used for components or devices that can be bonded directly onto a substrate, board or carrier face-down. The connection is made through conductive bumps placed on the surface of the die.

Flip chip bumping is a vital step to the process. The bump provides the necessary electrical connection between the die and the substrate. This connection provides thermal conduction through the two materials as well as acts as a "spacer" to provide mechanical support and electrical conductivity.

Flip chip processes have been around for more than 40 years. Since then, thousands of applications have taken advantage of the size and cost benefits enabled by the flip chip assembly method.

INTRODUCTION TO FLIP CHIP

At a top level, flip chip involves three critical steps:



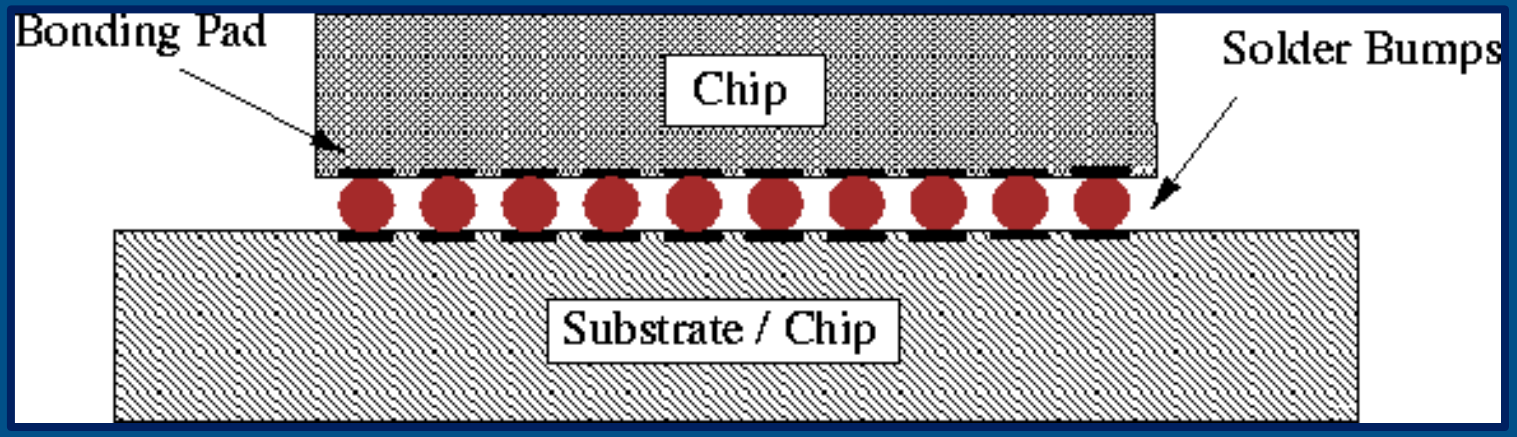
Die is picked up and place on a "flipping device"

Die is "flipped" and moved to hover over the substrate (or board or carrier) where bumps reside - precisely positioned in their previously defined positions

The tool then places the die on the bump with a programed amount of force

COMMON FLIP CHIP BUMPING PROCESSES

SOLDER BUMP



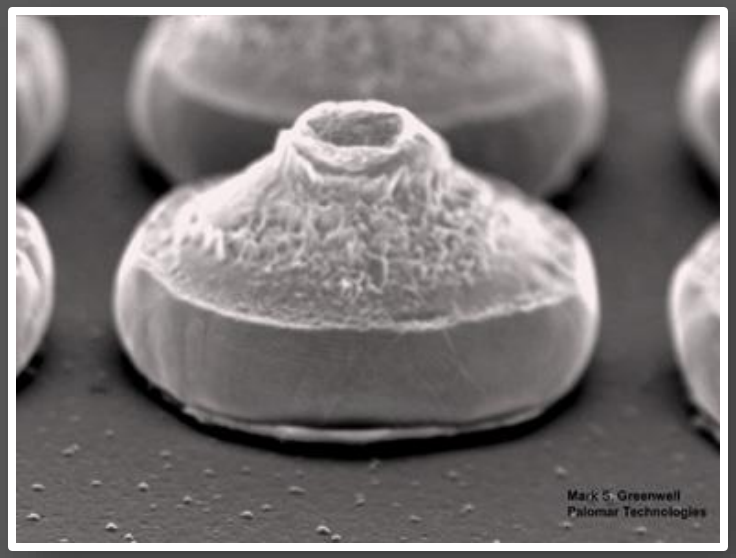
The solder areas on the chip bonds are defined with Under Bump Metallisation (UBM).

After the solder is deposited over the UBM, the wafer is sawn into bumped die.

The bumped die are then ready to be placed on the substrate pads for attachment process.

COMMON FLIP CHIP BUMPING PROCESSES

STUD BUMP



Stud (or ball) bumping is a modification of a wire bond process. The optimization of any gold flip chip process is achieved by optimizing the bump shape. New bump formation techniques have been developed that can create a gold bump without the traditional tail. This bump was designed specifically for a thermocompression or thermosonic bonding process. This shape directs the compression forces to assist in the formation of an intermetallic bond.

By focusing the applied energy down to a smaller surface area, the other bond parameters (heat, force, and ultrasonics) can be reduced. As this bump continues to be compressed and deformed, the surface area in contact will grow to increase the conductive area.

The wafer can then be sawn into a bumped die before being placed on the substrate pads and the interconnection made.

The gold stud bump process can be performed on a single die, as well as a whole wafer.

COMMON FLIP CHIP BUMPING PROCESSES

ADHESIVE BUMP

Conductive adhesive is stenciled on the UBM to form bumps on the wafer bond pads and is then cured.

The wafer is then sawn into a bumped die before being placed on the substrate pads for attachment process.

PLATED BUMP

Nickel-gold bumps are formed on the wafer by electroless nickel plating.

After the appropriate thickness of nickel is applied, an immersion gold is added for protection.

The wafer is then sawn into bumped die before being placed on the substrate pads and the interconnection made.

FLIP CHIP CONNECTION PROCESS

Need to automate flip chip die attach? Learn about the 3880 Die Bonder.

ICs are created on the wafer

1

2

Bond pads are metalized on the surface of the IC

Bonds pads have solder bumps added to the top of the wafer

3

4

The die is then flipped upside down with the bumps facing down

The external circuitry (on the PCB, package, substrate) has its pads facing upward

5

6

The bumps on the chip and the bond pads on the circuitry are aligned for targeted contact

The solder bumps are reflowed, completing the chip attachment

7

8

Mounted chips are under filled with an adhesive

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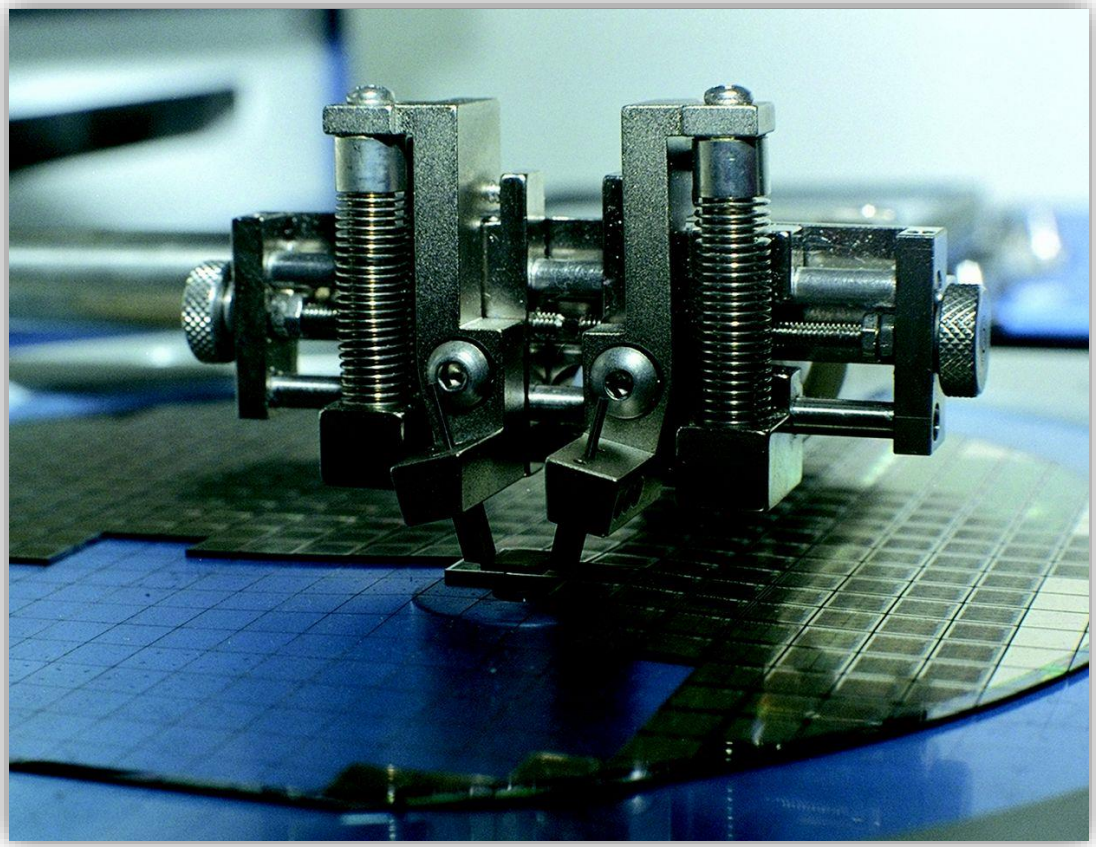
THE UNDERFILL PROCESS

The space between the chip and the substrate is typically filled with a non-conductive adhesive (underfill). The underfill material is dispensed around the edge of the die and capillary action pulls the material under the die.

The under fill material is crucial for additional robustness to the joint and compensates for any mis-alignment between the die and substrate. The underfill also protects the die from moisture and other environmental conditions.

FLIP CHIP ADVANTAGES



There are several advantages to the flip chip assembly process, including cost, component performance/reliability and design flexibility.

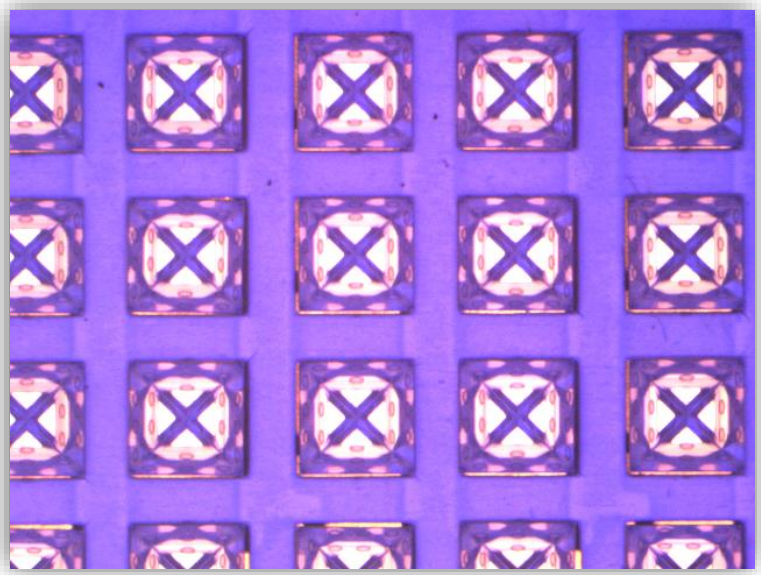
By flipping the device directly to the external circuitry, bond wires can be removed from the equation completely. This can reduce package sizes and weights significantly.

Smaller package designs typically translate to reduced production costs.

FLIP CHIP ADVANTAGES

Flip chip process—such as direct chip attach (DCA)— can eliminate the needs for wire bonds. Wire bonding can be considered a peripheral technology for flip chip applications since the number of external connections to the available surface area along the external peripheral of the die. More connections means larger die sizes. Eliminating the bond wires also results in the capacitance (the ratio of charge to potential on an electrically charged, isolated conductor) and inductance (a measure of the reaction of electrical components to changes in current flow by creating a magnetic field and inducing a voltage) of the electrical connections to greatly reduce which creates high-speed electrical connections.

And lastly, because flip chips are bonded directly onto other circuitry and can be filled with a robust, non-conductive adhesive (underfill), flip chips are ideal for end-use applications used in harsh climates —commonly for industrial or military industries.



FLIP CHIP VS. DIRECT CHIP ATTACH VS. COB

Flip chip is sometimes interchangeable with direct chip attach (DCA) when the chip is directly attached to the external circuitry via the conductive bumps. Direct-attach LEDs are the next generation of solid-state LED emitters that deliver superior value for consumer products and markets that include TV backlighting, camera flash and a variety of general illumination needs.

Today, Palomar Technologies Assembly Services™ is supporting more than 390 700µm LEDs that are attached with an Au/Sn solder to a single 50mm metal core carrier. Palomar Technologies' Pulsed Heat System is a major contributor to this development, allowing precision die attach systems to control LED exposure much more effectively than most other processes. The bondpad-down design of direct-attach LEDs eliminates the need for wire bonds,

yet improves the thermal management.

Learn more about Assembly Services solutions for flip chip and DCA

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FLIP CHIP VS. DIRECT CHIP ATTACH VS. COB

DCA assemblies can be called different names depending on substrate material, such as chip-on-glass (COG), chip-on-flex (COF), among others. When the flip chip process is incorporated with chip-on-board (COB), a successful attachment is enabled without using wire bonding by bumping the bond pads on the correct side (via flipping the chip) and directly attaching the chip.

With flip chip on board (FCOB), underfilling the chip is required to protect the chip's active surface from damage.

AUTOMATED FLIP CHIP SOLUTIONS

3880 DIE BONDER

The 3880 Die Bonder is designed for fully automatic, precision microelectronics assembly.

The 3880 Die Bonder is a flexible, computer-controlled die bonder and automated component placement system that performs flip chip operations over a large work area. It also contains a look-up camera with flip chip vision processing.

Download the 3880 Die Bonder Data Sheet

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AUTOMATED FLIP CHIP SOLUTIONS

ASSEMBLY SERVICES

Palomar Technologies Assembly Services ("Assembly Services") is the contract assembly, process development, test and prototyping division of Palomar Technologies.

Assembly Services supports precision direct-chip attach (DCA) LED bonding for several years. The DCA process helps minimize design space by eliminating the need for wire bonds. With both anode and cathode terminations on the bottom side of the LED, controlling the amount of flux becomes even more important.

You cannot have any bridging between the anode and cathode. Assembly Services has perfected the precision and repeatability of the DCA process, allowing Palomar Technologies to support designs with high numbers of LEDs per part.

Download the Datasheet

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INTRODUCTION TO DIE SORTING

Die sorting is used to test and divide die from one wafer into categories of varying qualities or other characteristics. Although all die on a wafer are intended to be identical, this is almost never the case. **Sorting the die** according to their characteristics becomes **necessary** in order to achieve a **cost effective, high yield** device packaging production.

INTRODUCTION TO DIE SORTING

MEMS and DCA LEDs are two examples of fragile die requiring flip chip prior to die attach. A required step before the flip chip process is **die sorting** of these delicate die.

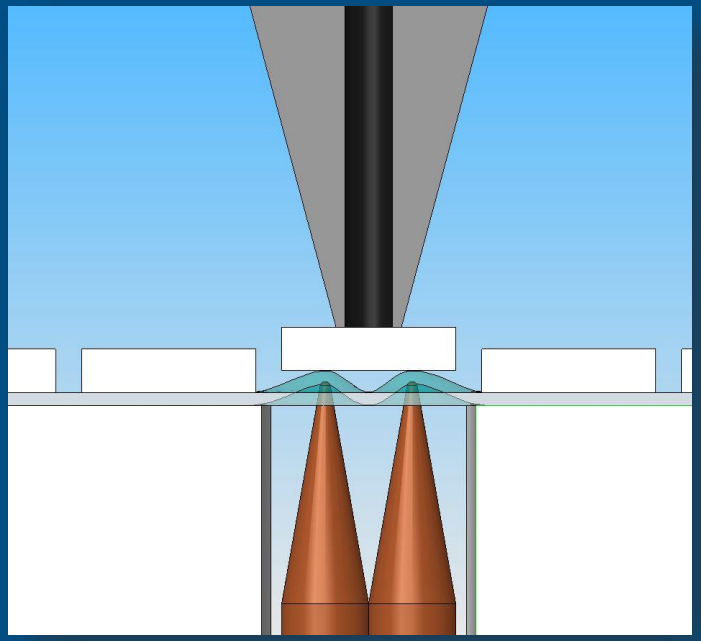
While traditionally MEMS die were removed by hand through the use of a needle and vacuum wand or tweezers, today's smaller, fragile and complex devices require a more precise process.

As microelectronics device designs evolve, so must handling and assembly processes. A common example is with the process of removing product from tape after wafer processing and dicing is complete.

AUTOMATING DIE SORTING PROCESSES

A die sorting system is designed to remove die from tape using an ejector mechanism and place them to output carriers, such as Gel-Pak, waffle pack, JEDEC tray, film frame or grip ring. Whether semi-automatic or fully-automatic, a die sorter offers a number of advantages over a manual die handling process.

Semi- and fully-automatic die sorters provide the user complete control over the exact die eject parameters, such as eject needle height, eject speed and placement pattern on the output through the use of process recipes. This allows repeatable processing from one die to the next of the same product, as well as different settings to be used for different products.



With every die picked in the same manner, process yield and throughput are increased while damage to devices from manual handling is eliminated. In addition, ergonomics for the operator is greatly enhanced.

FLIP CHIP AND MEMS ASSEMBLY WITH HIGH-MIX, AUTOMATIC DIE SORTERS

Flip chip (die flipping or die inversion) is also an option, making inline inversion of bumped die into output trays a simple process.

Royce Instruments, Inc., die sorters have uniquely solved many die handling problems in Laser Diodes, MEMS, Microfluidics, Ink Jet head, Lab on Chip (LOC) and BioChip manufacturing.

ROYCE Instruments

Download the Royce Instruments Datasheets

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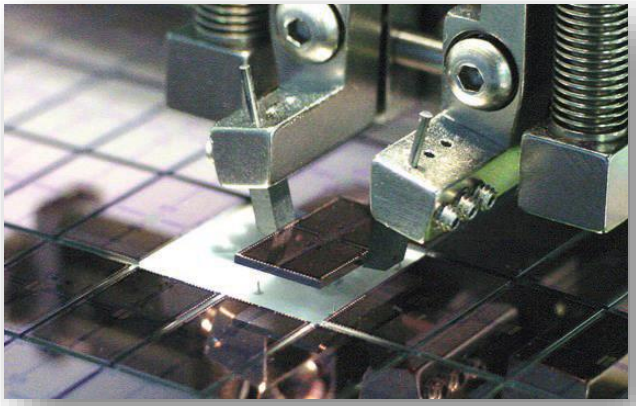
ROYCE INSTRUMENTS DIE SORTERS AT A GLANCE

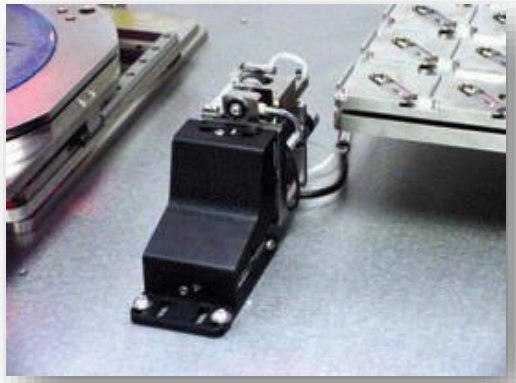
DE35-ST
Semi-Automatic Die Sorter

- Excels in sorting fragile GaAs and MEMS devices
- Available for up to 300mm wafers
- Picks die as small as 200 µm square
- Waffle Pak, Gel-Pak® and film frame output
- Underside and facet inspection options
- Die inverter option
- Throughput of 500-1200 UPH, (product, process dependant)
- Quick change over, under 10 minutes
- Optional non-surface contact operation for MEMS, air-bridge GaAs, optical and other sensitive devices



AutoPlacer MP300
Automatic Die Sorter

- Low cost automatic die sort from wafer to tray or film frame
- Reads many wafer map formats
- Supports Multi-Project, Pizza Map, Reticle Mask wafers
- Picks 50 µm thick GaAs with air bridges and vias
- Picks large, fragile, complex geometry MEMS devices
- Optional inline die inverter
- Flexible die binning with tray pocket traceability
- Wafer input up to 300 mm, film frames or rings
- Quick change output fixtures, Gel-Pak, waffle pack,
- Jedec trays, film frames



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SUMMARY

In flip chip assembly, the chips are mounted to a substrate, board, or carrier by flipping them over so that the top side faces down and the pads align with the corresponding pads on the external circuit; solder is then flowed to complete the interconnect. This is in contrast to wire bonding where the chip is mounted upright and wires are used to interconnect the chip pads with the external circuitry.

There are many advantages of the flip chip process, including that the need for wire bonding is eliminated (direct chip attach) and therefore can support a final application much smaller than their counterparts.

CONNECT WITH US

PALOMAR TECHNOLOGIES

Palomar Technologies, a former subsidiary of Hughes Aircraft, is the global leader of automated high-accuracy, large work area die attach and wire bond equipment and precision contract assembly services. Customers utilize the products, services and solutions from Palomar Technologies to meet their needs for optoelectronic packaging, complex hybrid assembly and micron-level component attachment. For more information, visit www.palomartechnologies.com.

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