Copper Pillar Test Sockets: Case Study

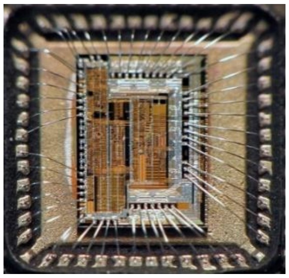
Introduction

An increasingly popular interconnect method for semiconductor wafers is the use of copper pillars. But, pillars create a difficult challenge for testing.

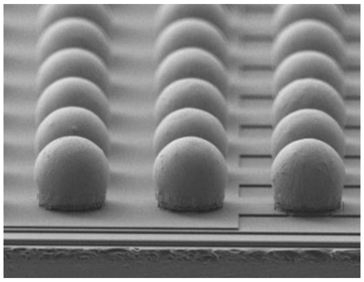
What are common methods for making wafer interconnects ?

Most ICs are connected to pads or a lead frame using thin gold wires. The wire-bonding pads are located along the circumference of the chip.

Solder balls are usually positioned in grid patterns along the bottom surface of the IC. When the chip is flipped over and IR heat is applied, the solder balls melt and form columns.



Wire bonding



Solder ball array

Why use copper pillars ?

Copper pillars can be made with very small geometries and placed as needed – anywhere on the surface of the wafer.

Copper offers excellent thermal and electrical conductivity.

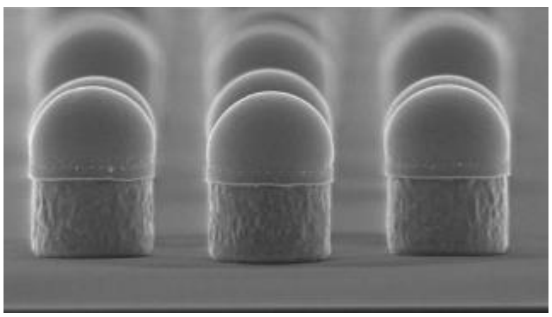
The pillars have excellent mechanical durability – especially in fine pitch applications.

What do copper pillars look like ?

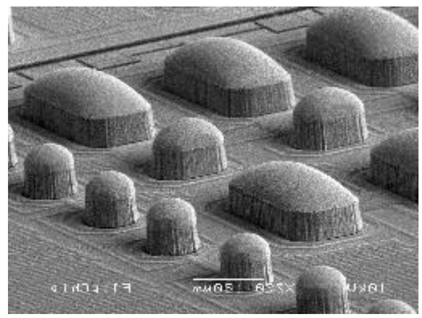
They are typically cylindrical, with a spherical cap of solder. They are made with an additive plating process using conventional photolithographic methods.

The pitch between pillars is 50µm to 300µm. The pillar height is 60µm to 100µm.

Like solder ball interconnects, the wafers are flipped over and the solder is melted to make the contact between the copper pillar and a contact pad.



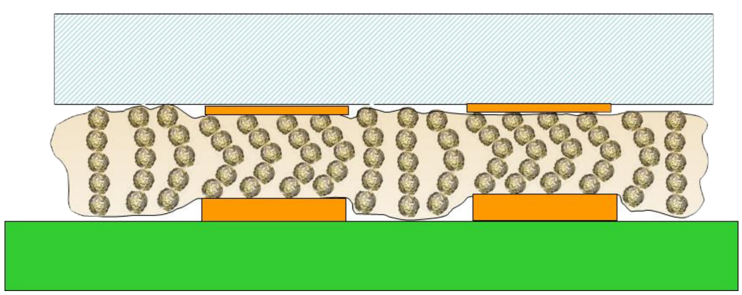
Copper pillars in an array



Copper pillars with multiple shapes

PariPoser® material

PariPoser® elastomeric material conducts electricity vertically, but not horizontally. Nickel nanoparticles are magnetically aligning into columns and held in position with silicone. When compressed between two conductive surfaces, the contact resistance of the nickel columns is about 20 mΩ.



PariPoser® material: compressed

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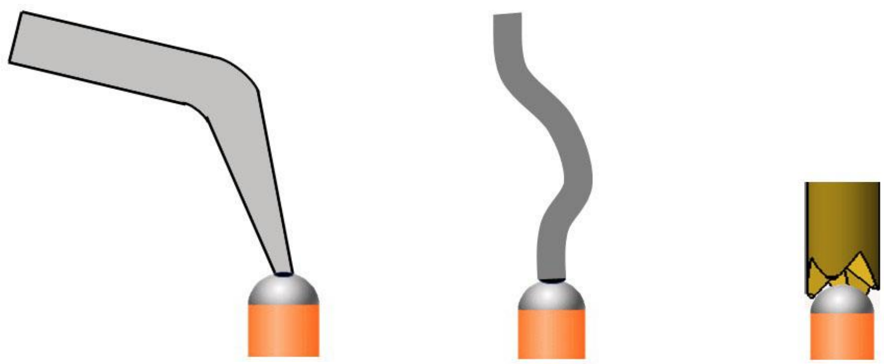
A copper pillar test socket

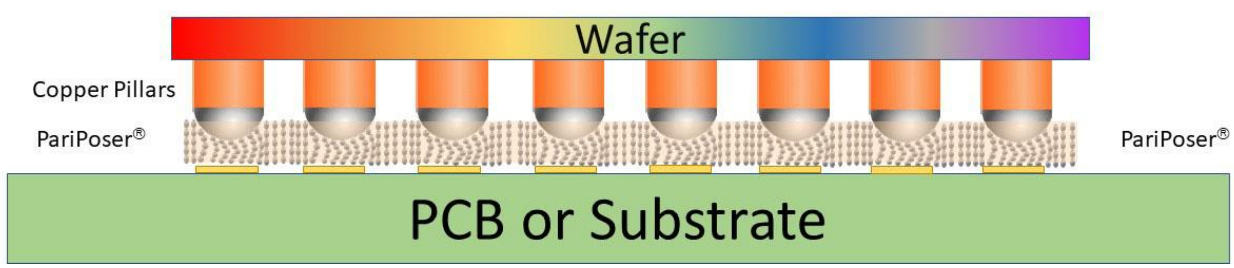
When designing a copper pillar test socket, the most important factor is the contact mechanism. That decision is mostly based on the pitch of the pillars.

If the pitch is very small, wafer probing methods are used – like probe needles, buckling beams or MEMS contacts. If the pitch is quite large, conventional Pogo pins can be used. In all of these cases, a pointed metal probe tip has to be precisely guided onto the solder cap to make the connection between the tester and the DUT.



Needle probe Buckling beam Spring pin

In the socket described below, the copper pillars are engaged by a thin sheet of PariPoser® elastomeric material. (The material is about 60μm/0.0024” thick.) Multiple nickel nanoparticle columns get compressed between the solder cap on the copper pillar and the DUT board pads.



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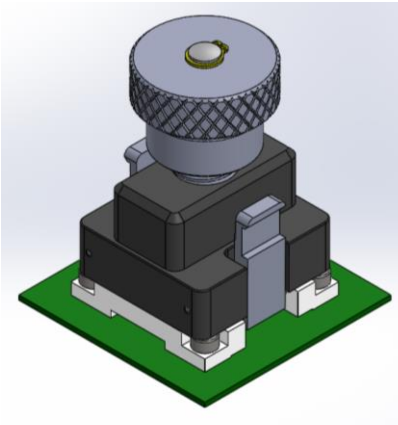
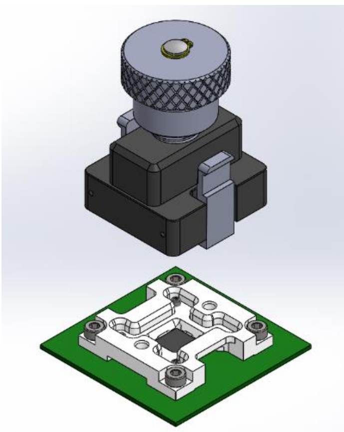
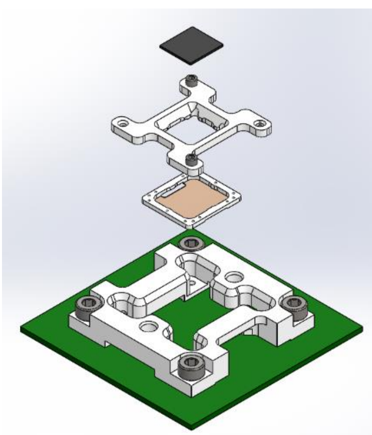


The assembled socket has a load-adjustment knob to apply the correct pressure to the wafer. The clips on the side keep the cover mounted to the base plate.



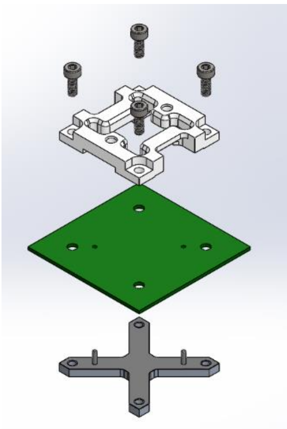
The top can be removed to reveal the inner workings of the socket, or for use in a contactor.



This exploded view shows the wafer, the alignment plate, the stretch frame with the PariPoser® material, and the base plate. The stretch frame with the contact material can be easily removed if worn or if contaminated by the solder.

The PariPoser® material is selected to match the pitch and the size of the copper pillars. Typically, the material for a copper pillar socket is the 0.1mm or the 0.2mm pitch version of the elastomer material.

A stretch frame holds the PariPoser® material taut and makes it easy to position the contactor into the socket.



Underneath the DUT board is a support plate that is secured to the base plate to prevent bowing.