

Apparatus for Precise Indium-Bump Bonding of Microchips

Bonding force is distributed more nearly evenly and controlled more precisely.

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An improved apparatus has been designed and built for use in precise positioning and pressing of a microchip onto a substrate (which could, optionally, be another microchip) for the purpose of indium-bump bonding. The apparatus (see figure) includes the following:

- A stereomicroscope,
- A stage for precise positioning of the microchip in rotation angle (θ) about the nominally vertical pressing axis and in translation along two nominally horizontal coordinate axes (x and y), and
- An actuator system that causes a bonding tip to press the microchip against the substrate with a precisely controlled force.

In operation, the microscope and the stage are used to position the microchip under the bonding tip and to align the indium bumps on the chip and the substrate, then the actuator system is used to apply a prescribed bonding force for a prescribed time.

The improved apparatus supplants a partly similar prior apparatus that operated with less precision and repeatability, producing inconsistent and unreliable bonds. Results of the use of the prior apparatus included broken microchips, uneven bonds, and bonds characterized, variously, by overcompression or undercompression. In that apparatus, the bonding force was generated and controlled by use of a micrometer head positioned over the center of a spring-loaded scale, and the force was applied to the microchip via the scale, which was equipped for digital readout of the force. The inconsistency of results was attributed to the following causes:

- It was not possible to control the bonding force with sufficient precision or repeatability. Particularly troublesome was the inability to control the force at levels less than the weight of 150 g.
- Excessive compliance in the spring-loaded scale, combined with deviations from parallelarity of the substrate and



This **Microchip-Bonding Apparatus** produces better, more repeatable microchip/substrate indium bump bonds than did a prior apparatus.

bonding-tip surfaces, gave rise to nonuniformity in the pressure applied to the microchip, thereby generating excessive stresses and deformations in the microchip.

In the improved apparatus, the bonding tip and the components that hold the substrate and the microchip are more rigid and precise than in the prior apparatus, so as to ensure less deviation from parallelarity of the bonding-tip and substrate surfaces, thereby ensuring more nearly uniform distribution of bonding force over the area of the microchip. The bonding force is now applied through, and measured by, a load cell that makes it possible to exert finer control over the force. The force can be set at any value between 0 and the weight of 800 g in increments of 0.2 g.

This work was done by Larry Wild, Jerry Mulder, and Nicholas Alvarado of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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