Flip-chip bonding: how to meet the high accuracy requirements?

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What is flip-chip?

**Advantages**
- Reduce the length of interconnections
- Increase the number of I/O
- Reduce the size of package
Need for high accuracy

Evolution in bumping method

100 μm
150 -200 μm pitch

50 μm
100 μm pitch

20 - 30 μm
30 - 60 μm pitch

15 - 20 μm
20 – 40 μm pitch

10 μm
20 μm pitch

5 μm
10 μm pitch

IMC area

Standard flip chip bump

Fine-pitch bump

Solder microbump

Cu pillar bump

SLID

Indium bump (lift-off)

Courtesy of Sami Vahanen – Advacam/CERN – ESE 2010
Need for high accuracy

What does it mean?

10mm

1µm

1µm

0.17mm

0.17mm

1700mm
Need for high accuracy

Key parameters

Environment

Components & Process

High accuracy Flip-chip bonder
Need for high accuracy

- Components
  - Good alignment marks onto the components
  - Shape of bumps
  - Choice of material
  - Cleanliness of components
Need for high accuracy

- **Environment**
  - Stability of temperature

**Quartz test chips on FC300 100 N – 200°C**

![Graph showing the accuracy and temperature over time](chart.png)
Need for high accuracy

Key parameters

- Environment
- Components & Process
- High accuracy Flip-chip bonder
3 steps for achieving high accuracy bonding

- **Alignment step**

  ![Diagram showing alignment steps: Upper image, Superimposed images, Lower image]
3 steps for achieving high accuracy bonding

How to align precisely?

- High resolution optics
  - Objectives
  - Lighting

- Alignment in live with a real microscope

- Superimposed images

- High resolution stages
  XYZTheta

Field of view with 20X objectives

Field of view with 50X objectives
3 steps for achieving high accuracy bonding

- Placement step
3 steps for achieving high accuracy bonding

How to place precisely?

- Calibration method in order to make match the bonding arm axis with the visual axis
3 steps for achieving high accuracy bonding

Post-bond accuracy
3 steps for achieving high accuracy bonding

- **Post-bond accuracy**

  - Adhesives: Non-Conductive
  - Adhesives: Isotropic Conductive

  
  ![Post-bond accuracy diagram](image)

  - Adhesives: Anisotropic Conductive
  - UV

  - Adhesives: Polymer Bumps
  - Direct bonding

  - Thermo-compression
  - Thermosonic

  - Mass Reflow
  - In Situ Reflow
3 steps for achieving high accuracy bonding

Application: Assembly of large IR detector

Process: Room temperature compression
- Metallisation: Indium bumps
- Force: 2000 N
- Temperature: RT (~20°C)

Challenge
- Keep accuracy under high forces
Post-bond accuracy – Key elements

- **Stiff structure**

- **Control of parallelism**

- **Z-motion bonding arm**
3 steps for achieving high accuracy bonding

Application: laser diode bonding

Process: Reflow
- Metallisation: Solder
- Forces: 0.6 N
- Temperature: 350°C

Challenge
- Keep accuracy under high temperatures
Post-bond accuracy – Key elements

- Limit the temperature variations

Alignment at room temperature

Alignement at 350°C
3 steps for achieving high accuracy bonding

Application: Chip-on-flex – Probes for brain

Process: Thermosonic bonding
- Metallisation: Au stud bumps/Au pads
- Force: 8N
- Ultrasonic power: 100W
- Temperature: 280°C

Challenge
- Keep accuracy under forces, temperatures and vibrations
Post-bond accuracy – Key elements

Handling of components

- Customized design
- Flatness
- Choice of material

Tool for substrate

Pipette for chip
Post-bond accuracy – Key elements

- Control and record each parameters
Conclusion

A close collaboration between you and us is the key to get good results
THANK YOU FOR YOUR ATTENTION

- ANY QUESTIONS?