Commissioning of a New Solder Bumping Process for the Pixel Upgrade

Summer Student Programme 2013

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DESY CMS Summer Student Talks
Hamburg, Sep 2nd 2013

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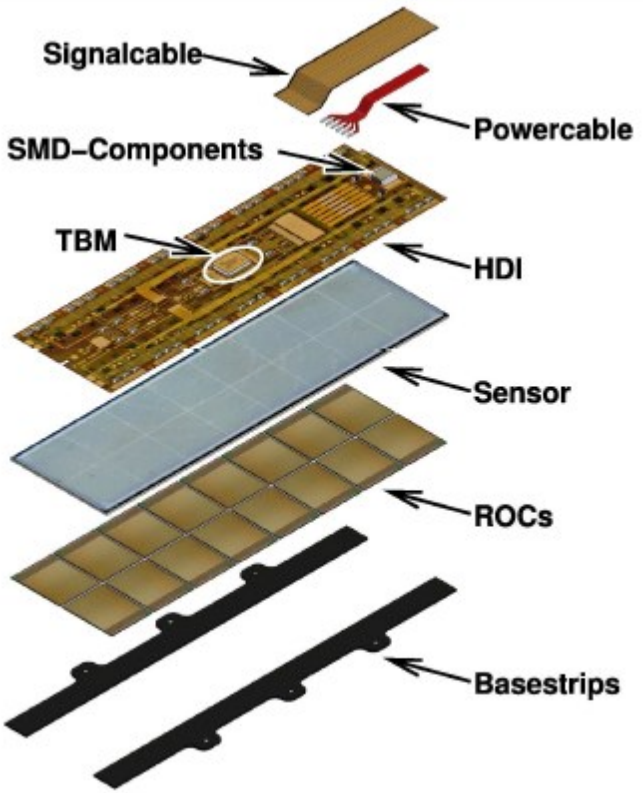
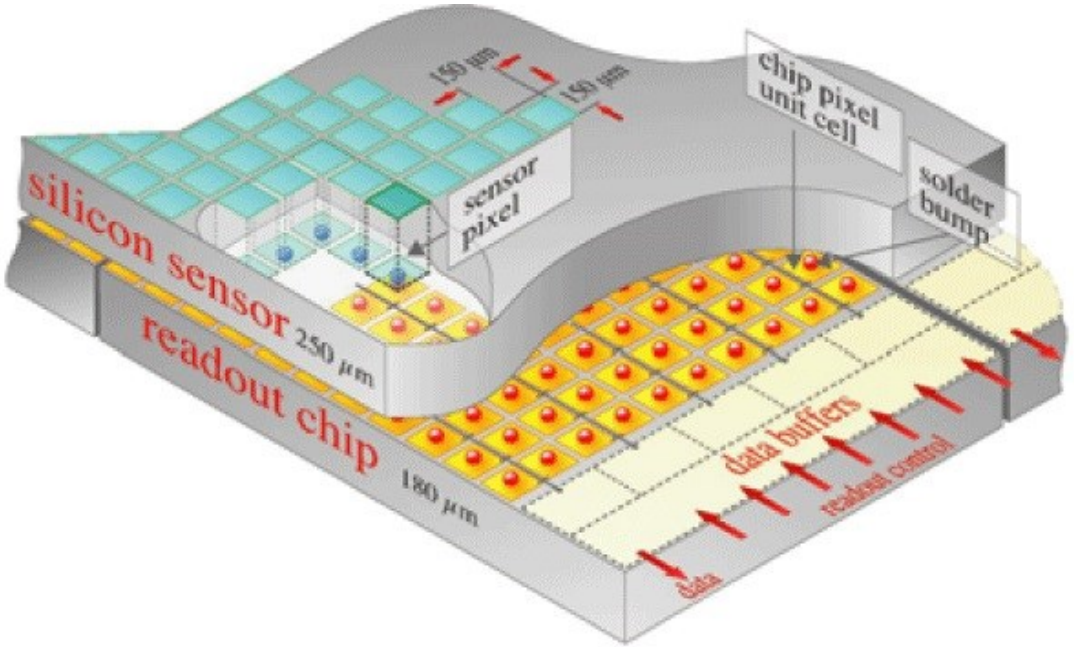
Agenda

- Introduction
- Bumping Process
- Inspection Methods
- Reflow Process
- Conclusions

Structure of the Pixel Detector Module





Pictures from „CMS Pixel Detector Upgrade, Daniel Pitzl, DESY Instrumentation Seminar 16.9.2011“

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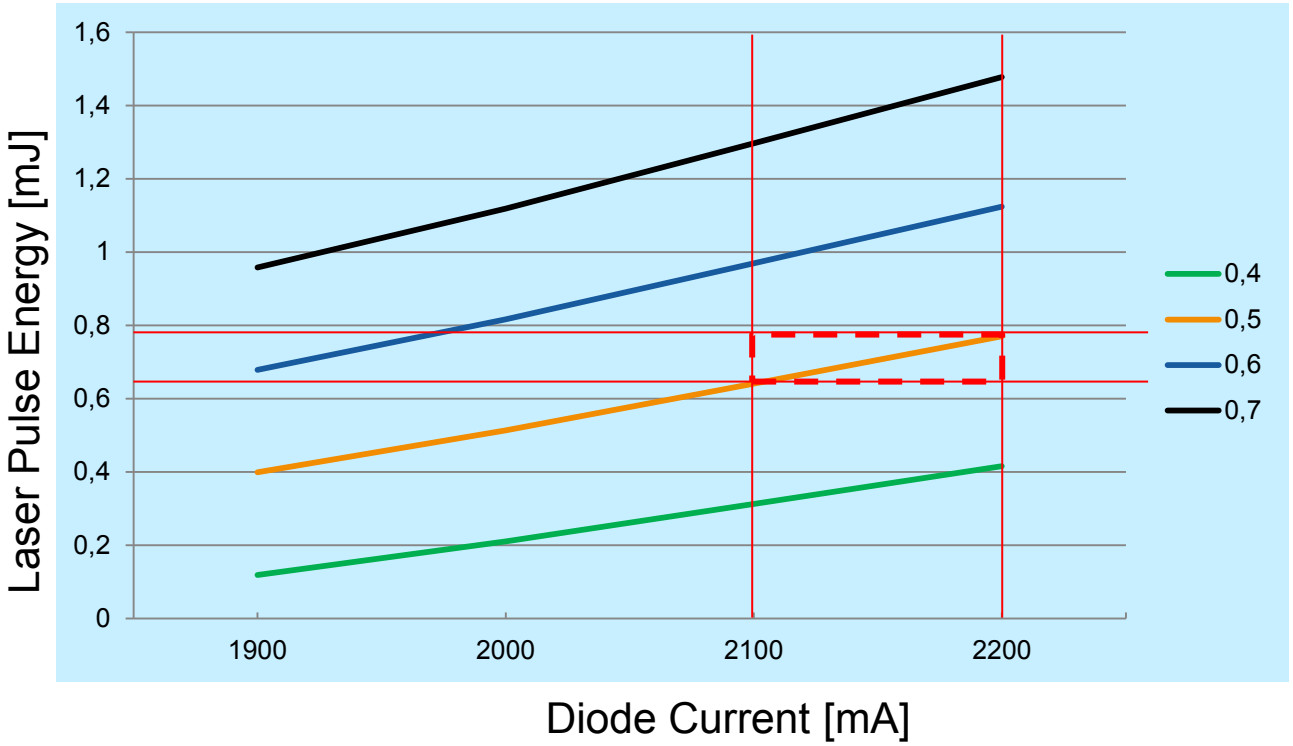
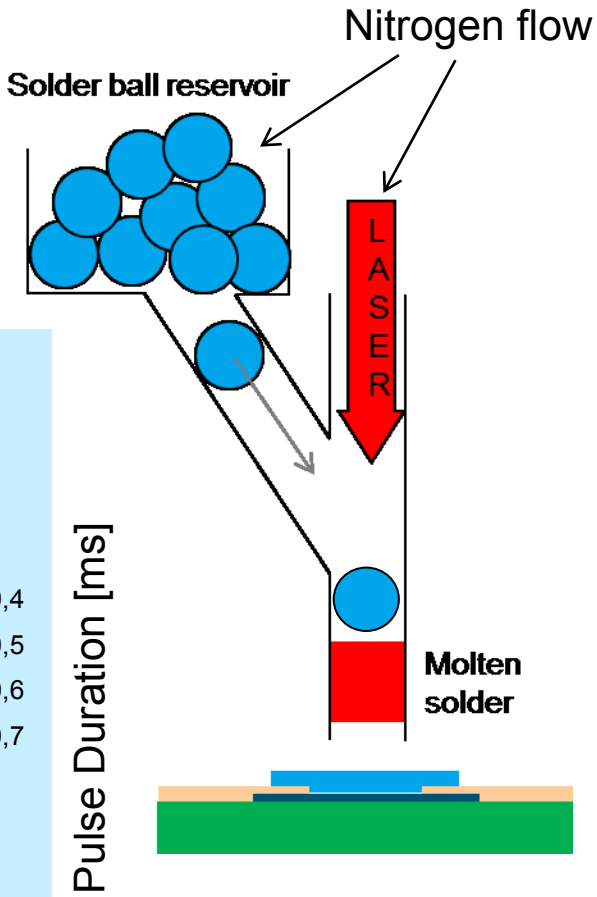
Bump Bonding Process

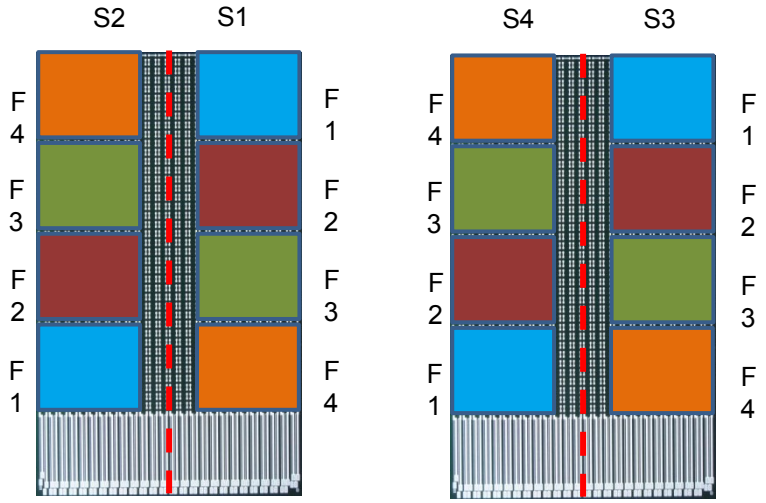
- Process speed is influenced by:
  - Pulse lenght
  - Pulse power
  - Feeder pressure





Bumping Parameter Settings Overview

- Number of columns = 20
- Number of rows per field = 19
- Number of bumps per field = 380
- One bump free row for field separation



	160 mbar		180 mbar	
	Sample 1	Sample 2	Sample 3	Sample 4
Constant Parameter	2100 mA	0.5 ms	2100 mA	0.5 ms
Field 1	0.4 ms	1900 mA	0.4 ms	1900 mA
Field 2	0.6 ms	2000 mA	0.5 ms	2000 mA
Field 3	0.7 ms	2200 mA	0.6 ms	2200 mA
Field 4	0.5 ms	2300 mA	0.7 ms	2300 mA
ΔE	0.33 mJ	0.12 mJ	0.33 mJ	0.12 mJ

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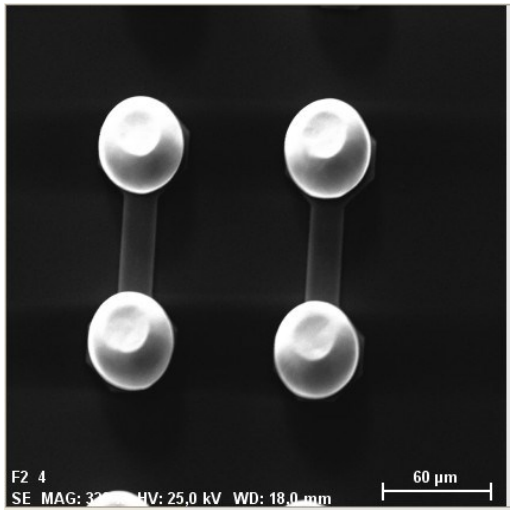
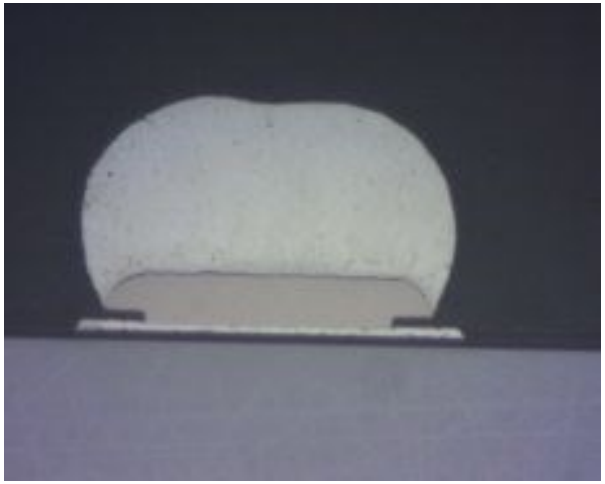
Inspections Methods

Example: sample 4 field 2

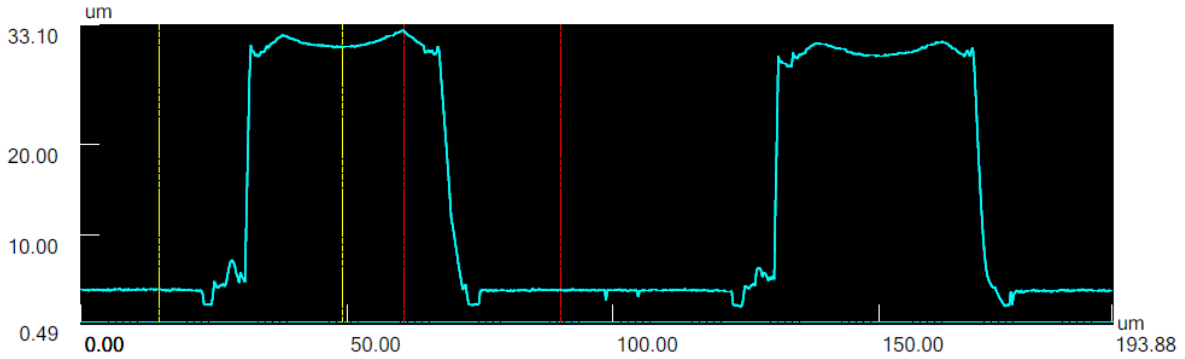
Scanning Electron Microscope



Optical Microscope Picture of cross-setion



Scanning Laser Microscope (dimensions in µm)



Results from the Bump Bonding

- Interactions between pads and bumps are negligibles
- Average speed: 4.8 Hz
- Optimal parameters are:
  - 2100 mA Laser diode current 0.5 ms Laser pulse lenght (0.64 mJ)
  - Lower energy limit to have good shaped bumps
  - „Saturation“ of the bump shape after the optimal energy

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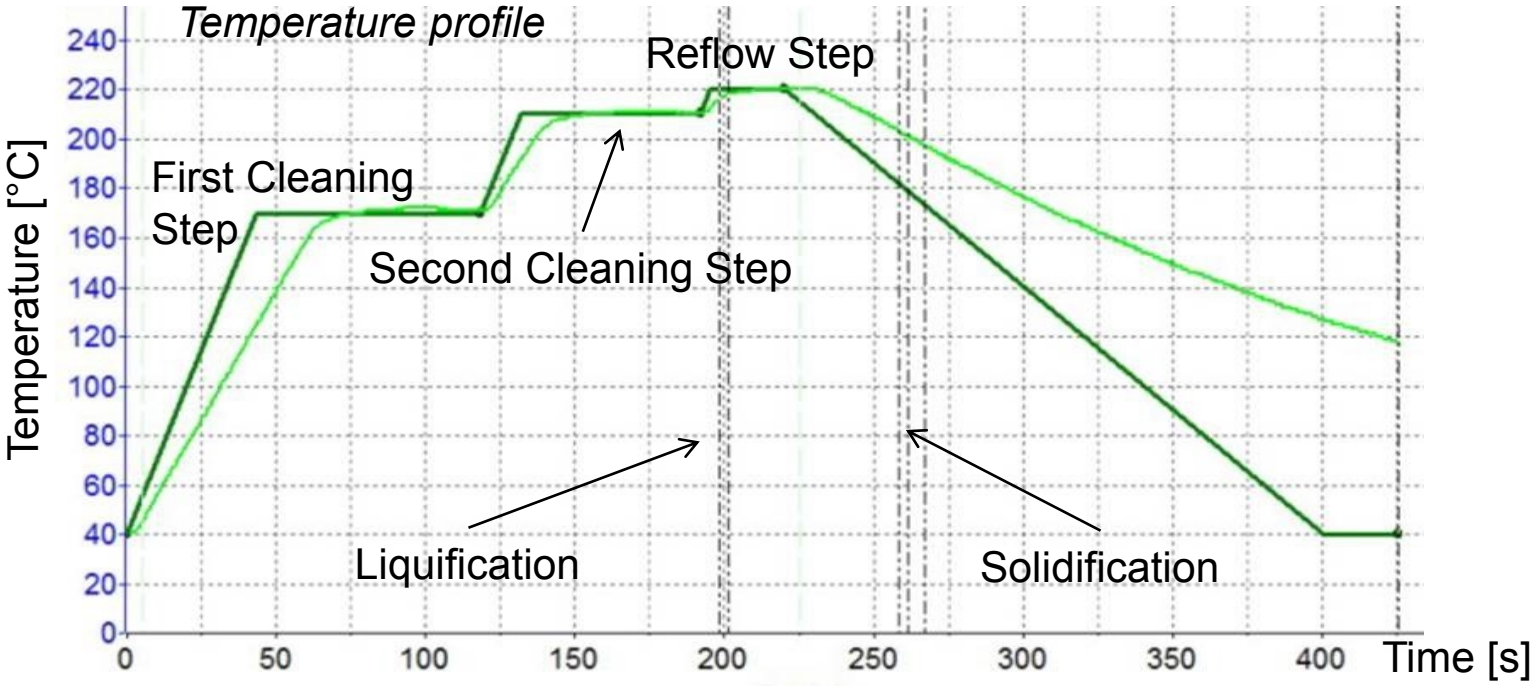
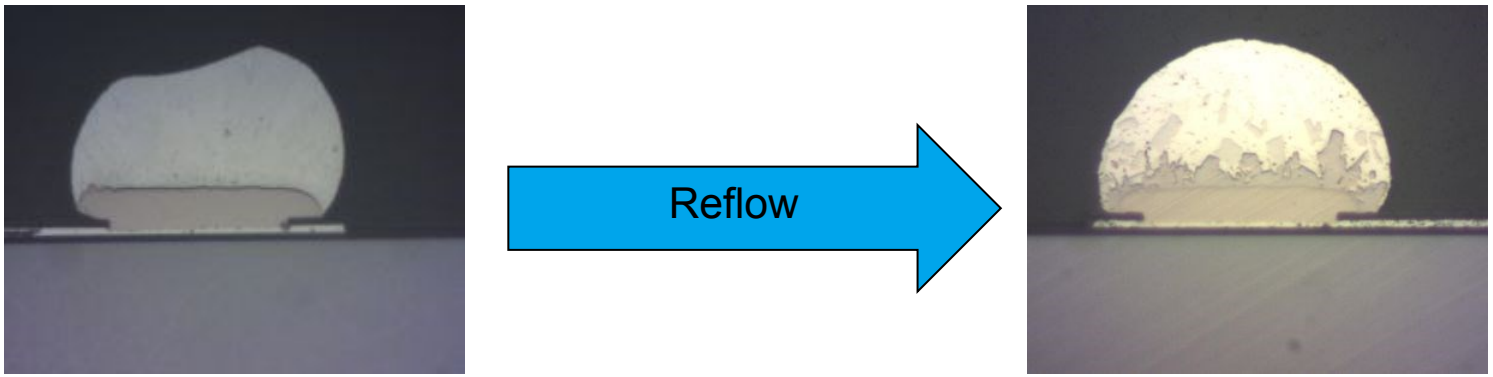
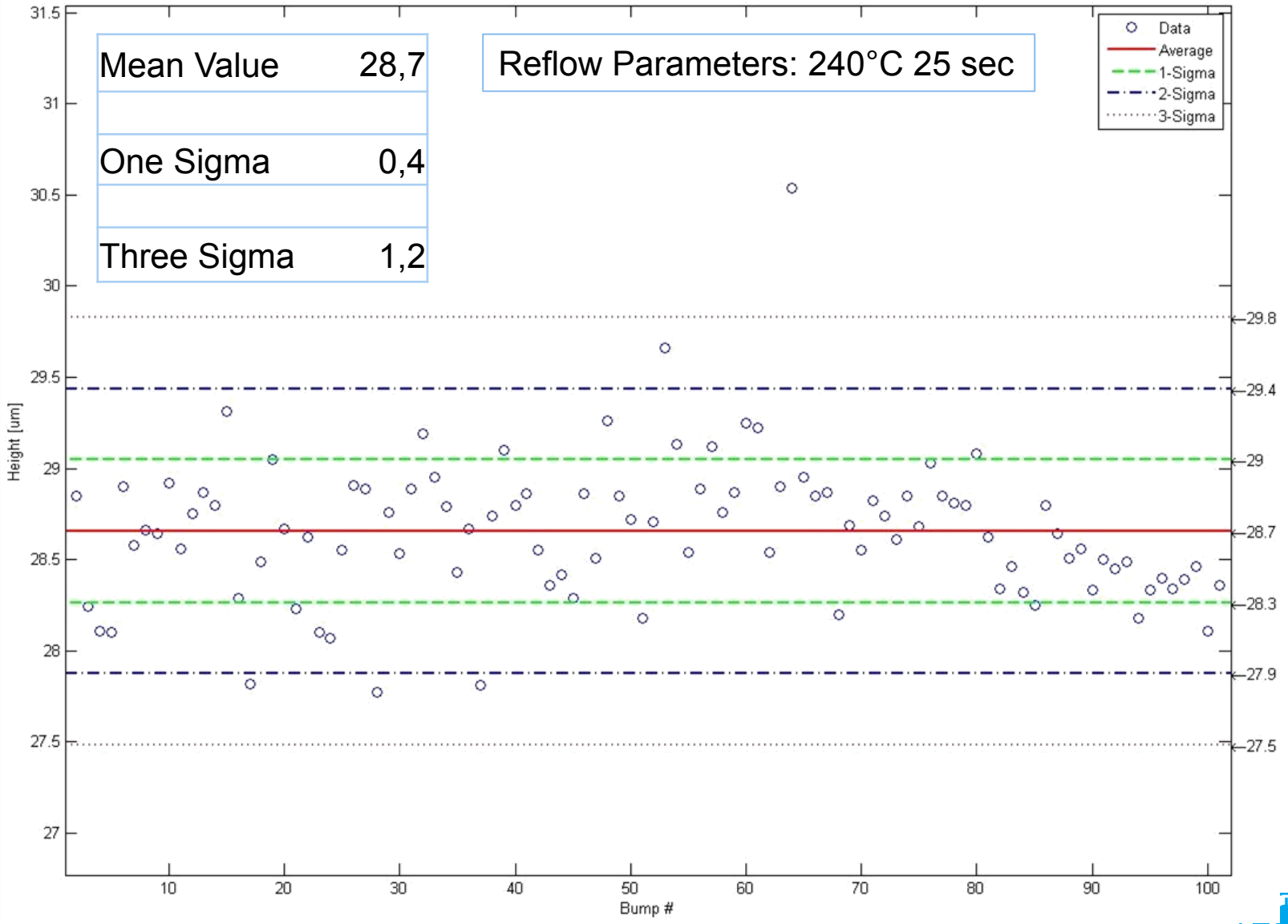
Reflow Process and Scans



Cross-section view before and after the reflow



Height Statistic Analysis after the Reflow



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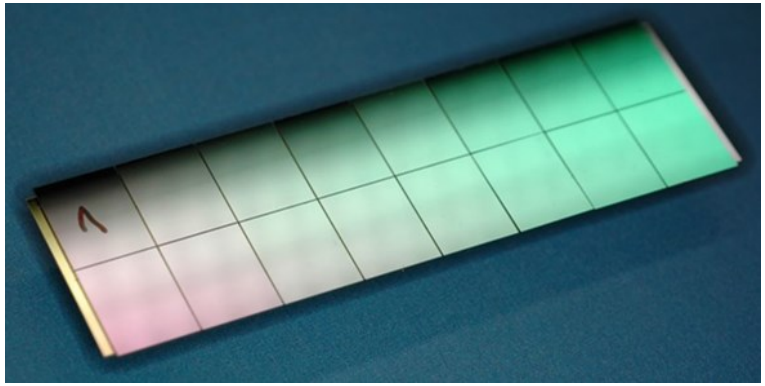
Results and Future Developments

- Bump Bonding Optimal Parameters: 2100 mA 0.5 ms 180 mbar
- Reflow Optimal Parameters: 220°C 10 s
- Improvements of the reflow process
  - Studies about interactions between bump and pad
    1. Temperature dependance
    2. Materials dependance
    3. Duration of the treatment
    4. Speed of the process
    5. Dimensions
    6. …
- Development of the flip chip bonding process



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Thanks for your attention!

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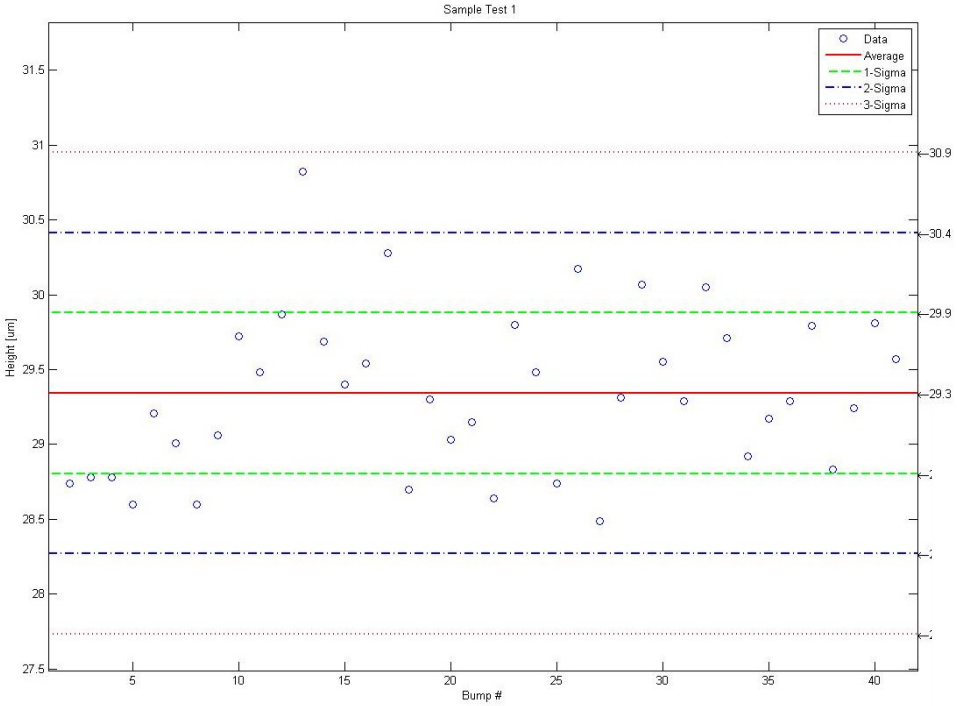
Back Up

Reflow Parameters



mean value r	29,8
one sigma	0,5
three sigma	1,5

Reflow Parameters: 220°C 10 seconds

Reflow Parameters: 220°C 25 seconds

mean value r	29,3
one sigma	0,5
three sigma	1,5