

HDP User Group International, Inc.

Mechanical Fatigue Test for Solder Joint Reliability



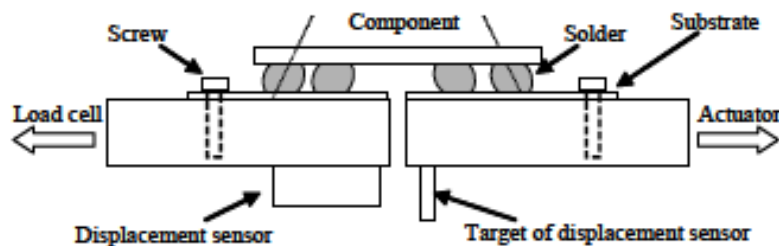
2007,09,19

Hironori Ohta, NEC Corp.

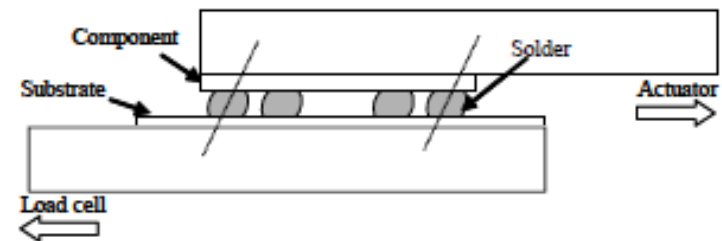
Background



- Shortening of the product development cycle requires a new method that can evaluate the reliability of solder joint in the short time instead of the conventional thermal cycle test.
- There are several proposals on the solder joint reliability test using the mechanical fatigue test from universities and an institute. Mechanical shear fatigue test have been proposed to IEC standards.



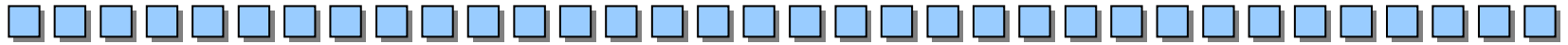
(a) Straddle method



(b) Lap shear method

Mechanical Fatigue Tests proposed to IEC

Purpose




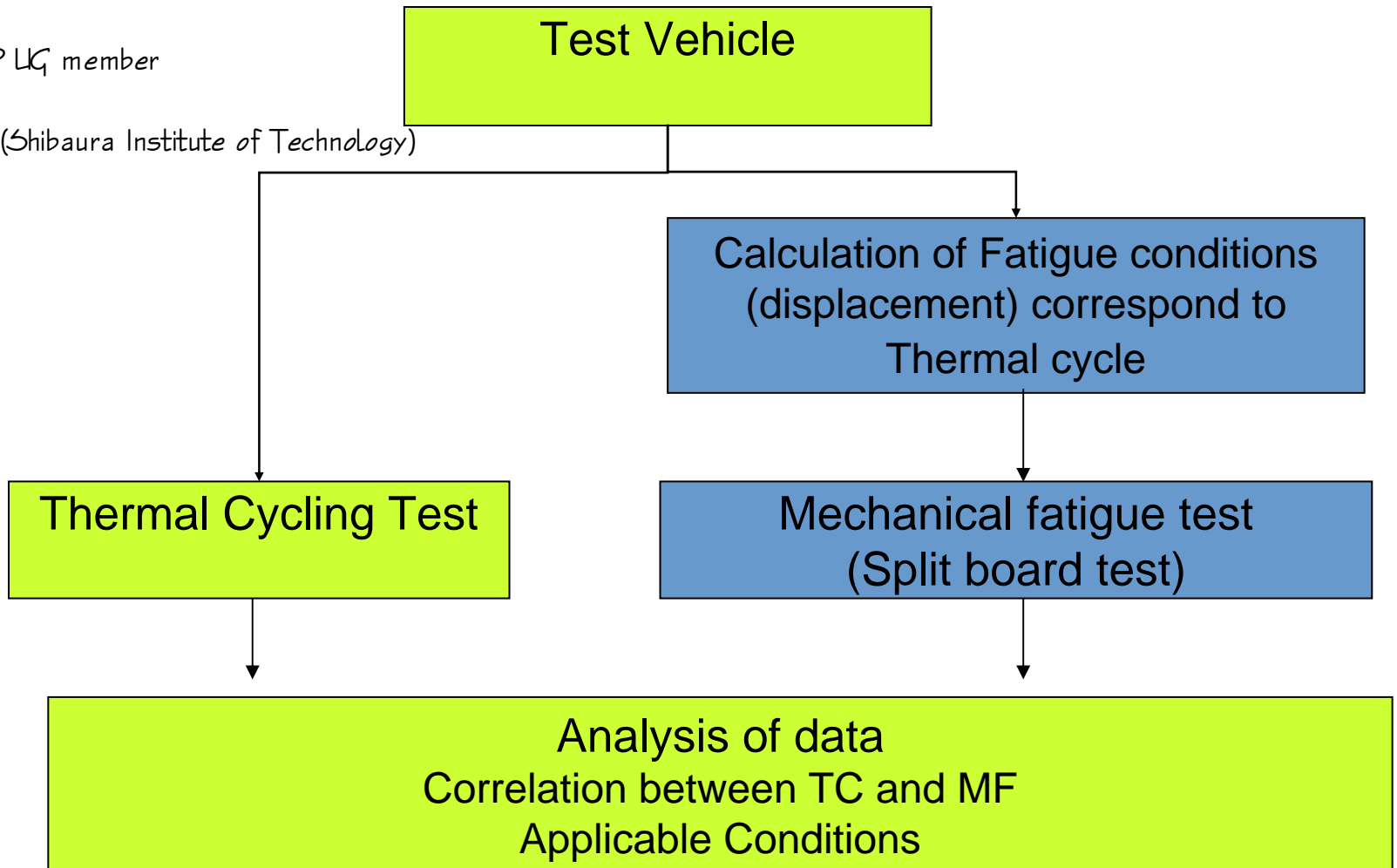
- Study on practicality and its issues of mechanical fatigue test as a solder joint reliability test
 - Data collection on mechanical fatigue test
 - Correlation of the reliability data between mechanical fatigue test and thermal cycling test
 - Finding the package and solder joint conditions where mechanical fatigue test can be used as the reliability test

Procedure

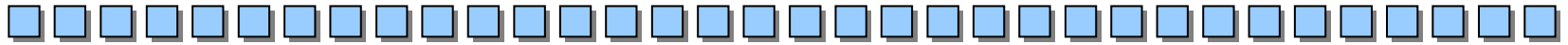


 HDP LG member

 ST (Shibaura Institute of Technology)



Test Vehicle



- PWB
 - New Design to meet test jig and equipment
- Packages
 - 0.4mm pitch /144 pins
 - Solder Ball: SAC, SA, SCNi
- Thermal test and Mechanical Test
 - Thermal test – Shibaura Institute of Technology
 - Mechanical Test – HDP User Group Member
- **Issue**
 - **SIT has no experience of fine pitch BGA. Trial test is required to confirm if 0.4mm package can be tested.**

Test Conditions



- Thermal Cycle : 0°C-100°C|-40°C-125°C
- Mechanical Fatigue Test : Room Temp., High Temp.
- Pretreatment : Level 3 (30°C/70%)(Fixed)

No	CSP*1 Solder Ball	Thermal Cycle	Mechanical Fatigue		No. Sample	Note
			Displacement	Temp.		
1	SnAgCu	0-100°C			12	HDP member
2		-40-125°C				
3			0-100°C equivalent	R.T.	3	SIT
4			0-100°C equivalent	H.T.*2	3	SIT
5			-40-125°C equivalent	R.T.	3	SIT
6			-40-125°C equivalent	H.T*2	3	SIT
7	SnAg	0-100°C			12	HDP member
8						
9	SnCuNi	0-100°C			12	HDP member
10						

*1 WL-CSP 0.4mm pitch /144 pins

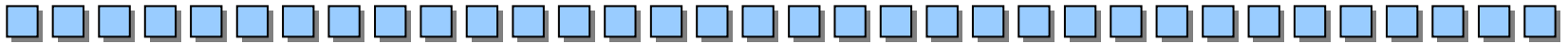
*2 In case SIT provides related data, no test will be performed.

Trial Test



- **Confirm if 0.4mm CSP package can be tested before fixing project plan**
 - CSP: NEC
 - PWB fabrication: CMK
 - Board assembly: NEC
 - Mechanical Fatigue Test : SIT

Deliverable



- Report
 - Correlation the reliability data between mechanical fatigue test and thermal cycle test
 - Finding the package and solder joint conditions where mechanical fatigue test can be used as the reliability test
- Paper
 - Presentation on a conference
 - Share raw data and detailed information within HDP User Group

Team Member and Role



- NEC: CSP package, thermal cycle test, analysis, failure analysis, report
- Fujitsu: Inspection of test vehicle, thermal cycle, failure analysis, report
- Nihon Superior: Solder ball and paste, report
- Freescale: Report
- SIT (Shibaura Institute of Technology): Mechanical fatigue test, report
- HDP User Group (Hiko Nakamura): Project facilitator

Schedule



Project Task		Orig.	Actual	Current Outlook
Trial Test				10/07
Project Plan		07/07		
Test Board Assembly		10/07		
Test Specimen		11/07		
Thermal Test		03/08		
Mechanical Test		03/08		
Analysis		06/08		
Final Report		10/08		

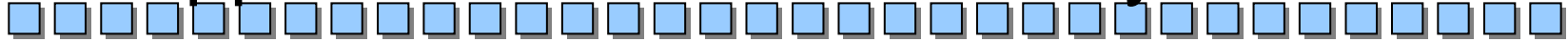
Expense



- Total Yen 2,060,000 (=US \$18,000)
 - Material
 - Solder Ball – 60,000
 - CSP Reball (Outsourcing) – 200,000
 - PWB Design and fabrication – 1,000,000
 - Board Assembly
 - Board assembly – 100,000
 - Mounting (Outsourcing) – 200,000
 - Test
 - Mechanical Fatigue Test (SIT) – 500,000

Next Phase Plan

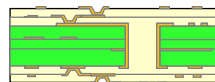
Application to PWB reliability



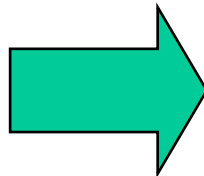
- Purpose
 - To study the possibility to apply mechanical fatigue test to the reliability of via/thru hole of PWB
 - Correlation of the reliability data between mechanical fatigue test and thermal test
 - Shorten the PWB reliability test
- Test Method
 - Conventional thermal shock test (MIL-STD-202 Method 107 condition B)
 - Test condition: $-65^{\circ}\text{C}/30\text{min} \leftrightarrow +125^{\circ}\text{C}/30\text{min}$
 - Mechanical Fatigue Test (Single Joint Fatigue Test)



General PWB



Build-up PWB



Take out the part of via/thru hole and attach it to the test jig

