Thermal Profile in Solder Paste Reflow Process

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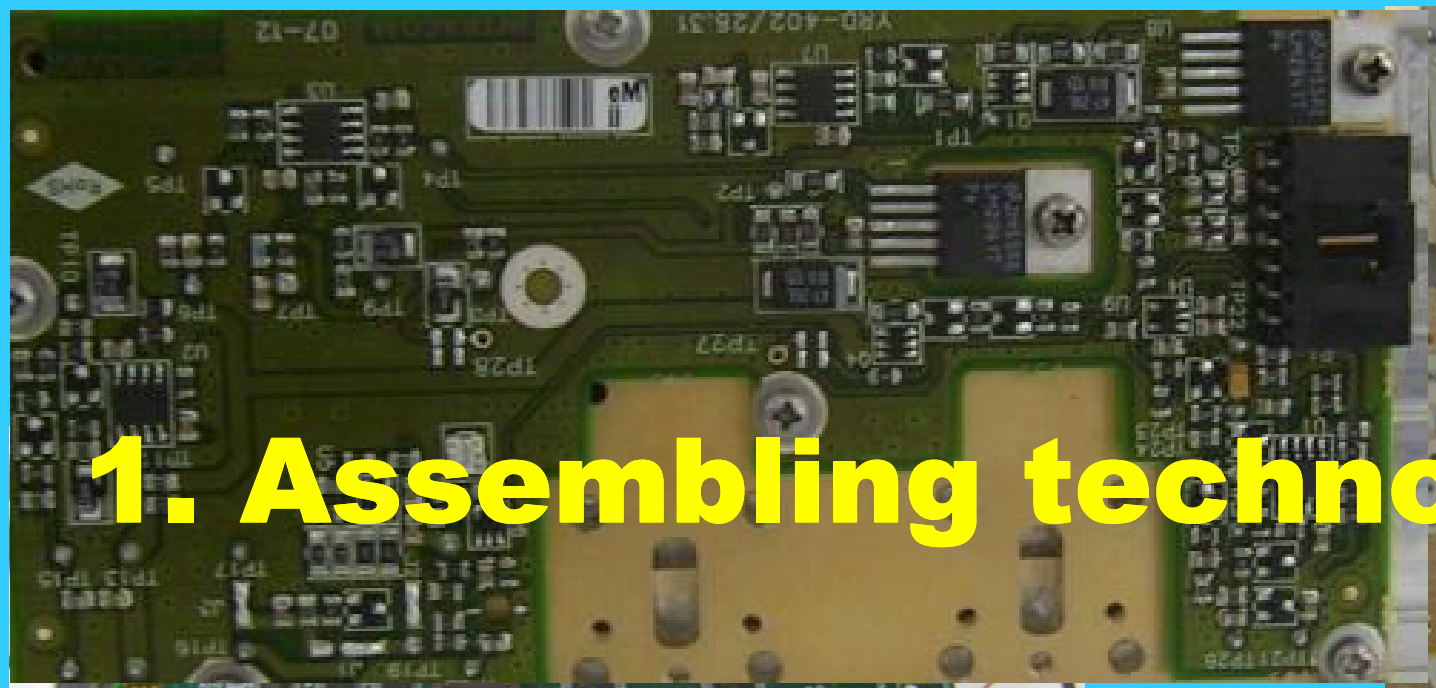
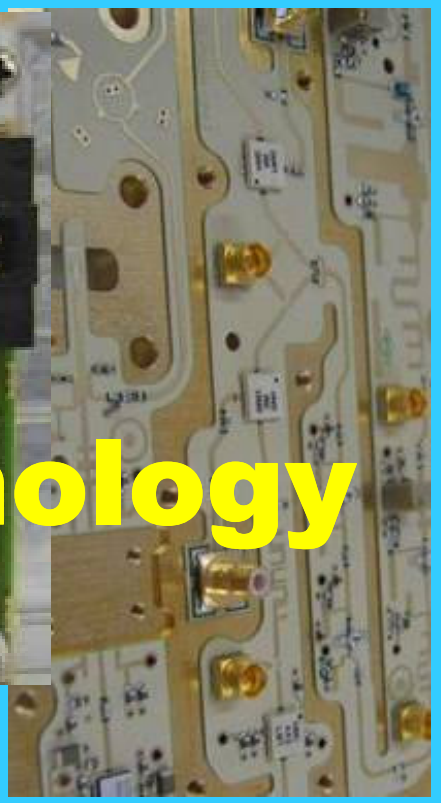
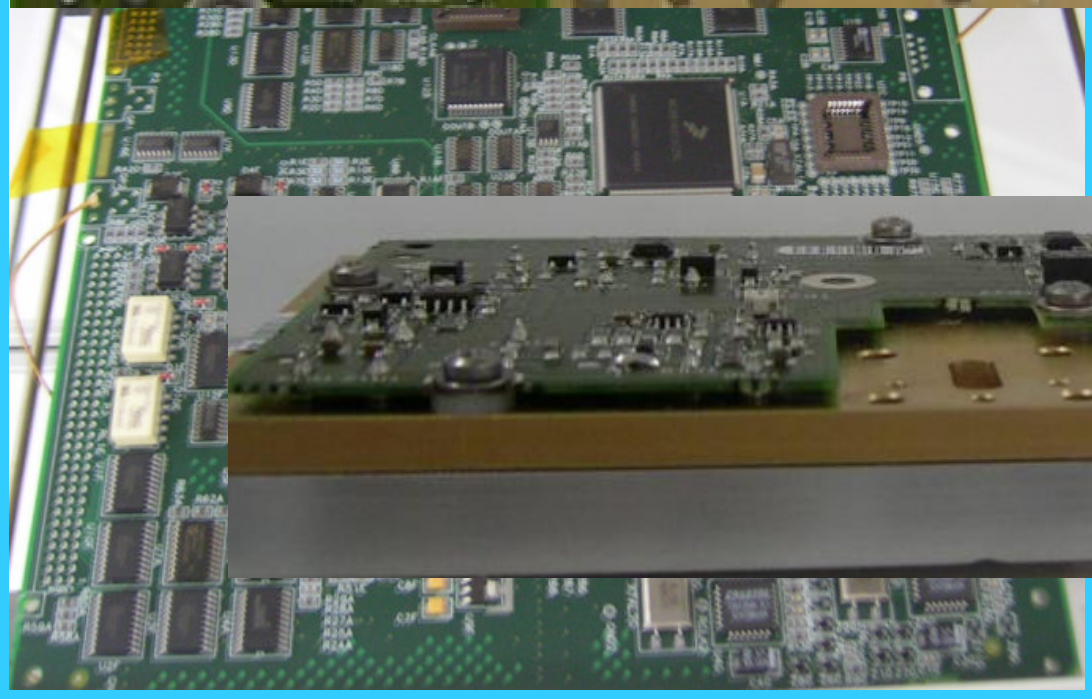
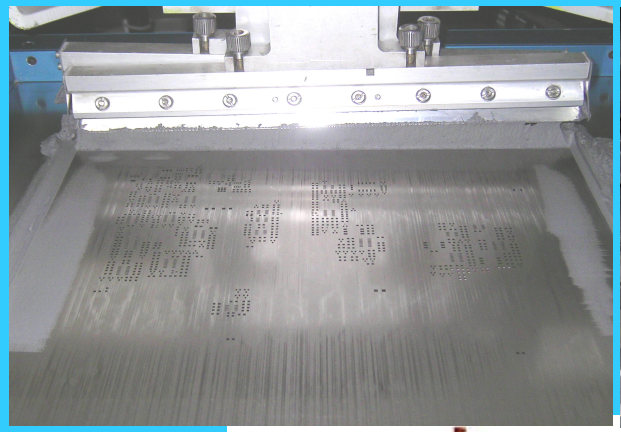
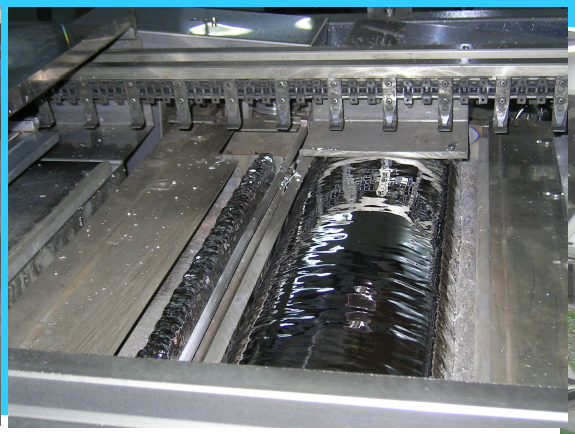
1. Assembling technology



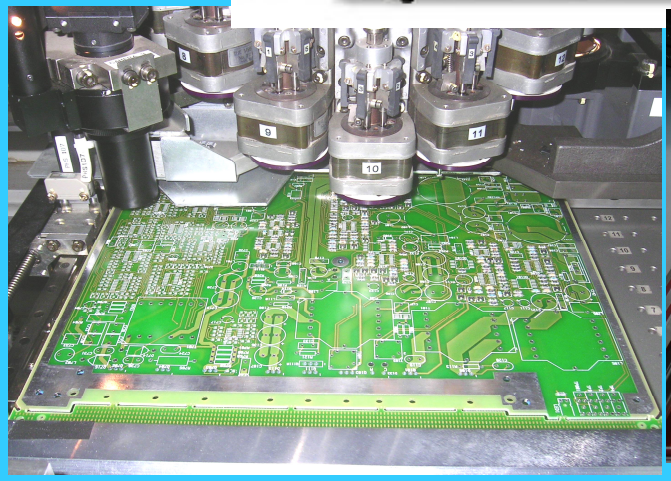


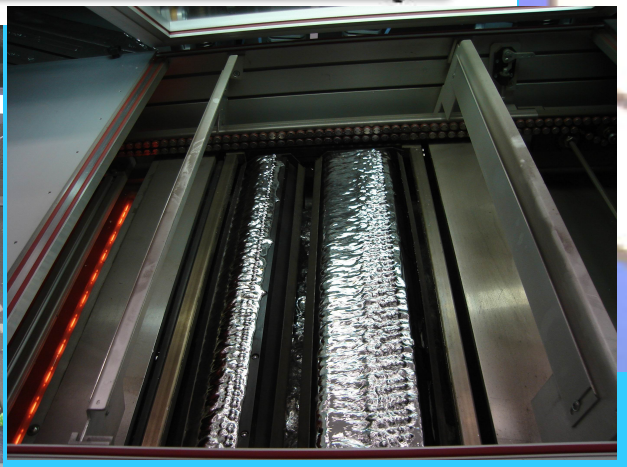







SEHO
SCIENSCOPE

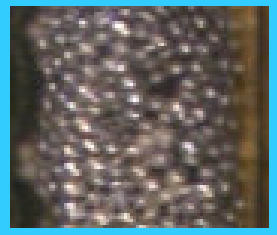




Elements of the joint

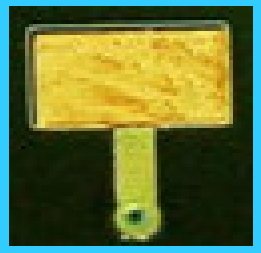
Component

Solder paste



Pad

NiAu, OSP, Ag-im, HAL, Sn-im



Thermal profile

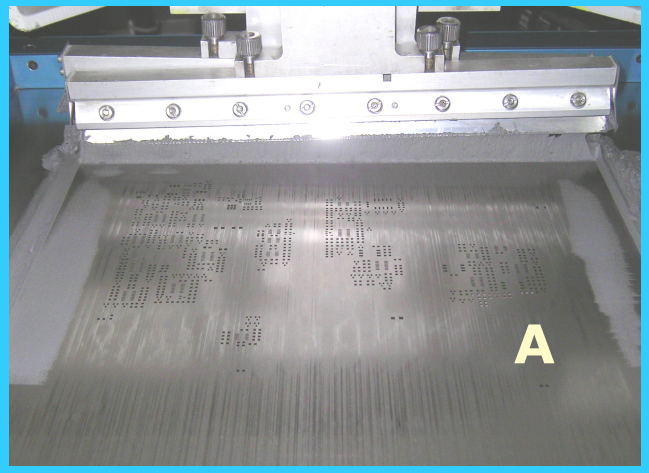
Reflow Process

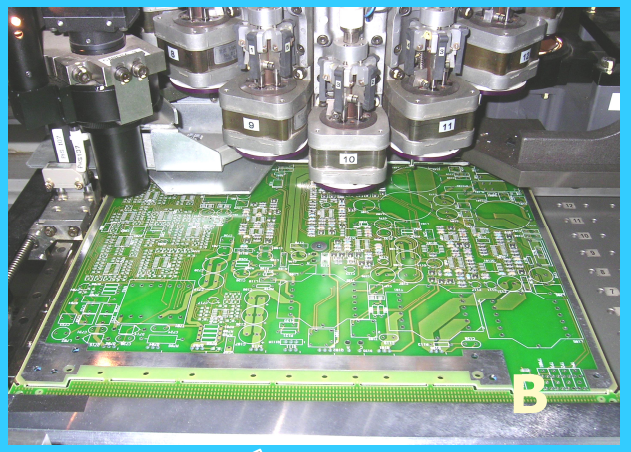
Joint

SMD solder joints

Surface Mount Technology (SMT):

A: Print, B: Pick in place, C: IR/Conv. Oven, D: VPS Oven.

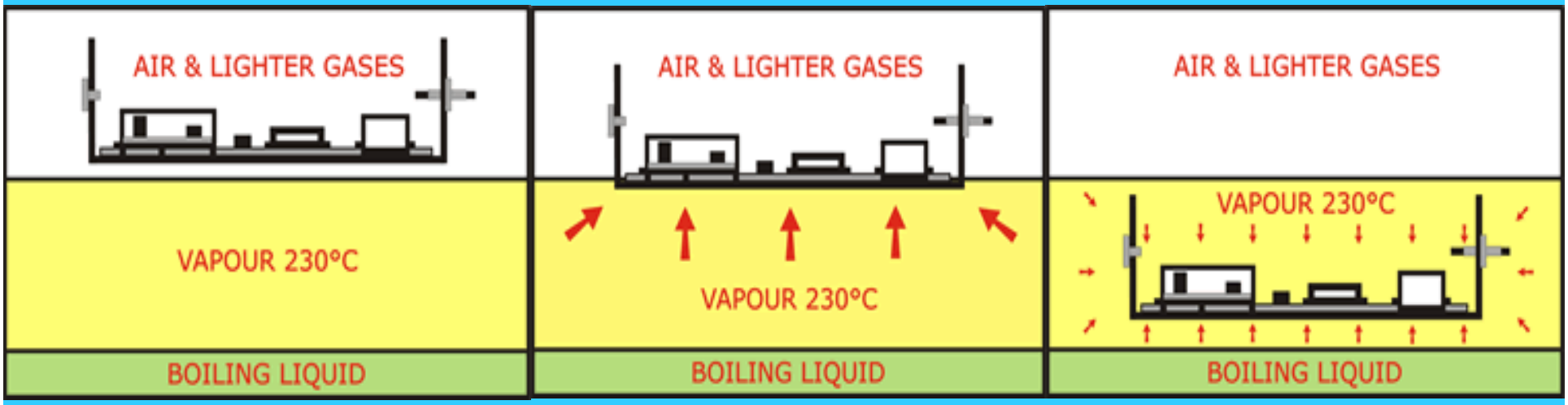




Vapour Phase Soldering technology

VPS advantages versus IR/Covection Lead-Free soldering process:

- **maximum temperature of 230℃;**
- **simultaneous solder in an oxygen free environment;**
- **without influence of the form, dimension or color of the electronics components and devices;**
- **without influence of the thermal mass.**



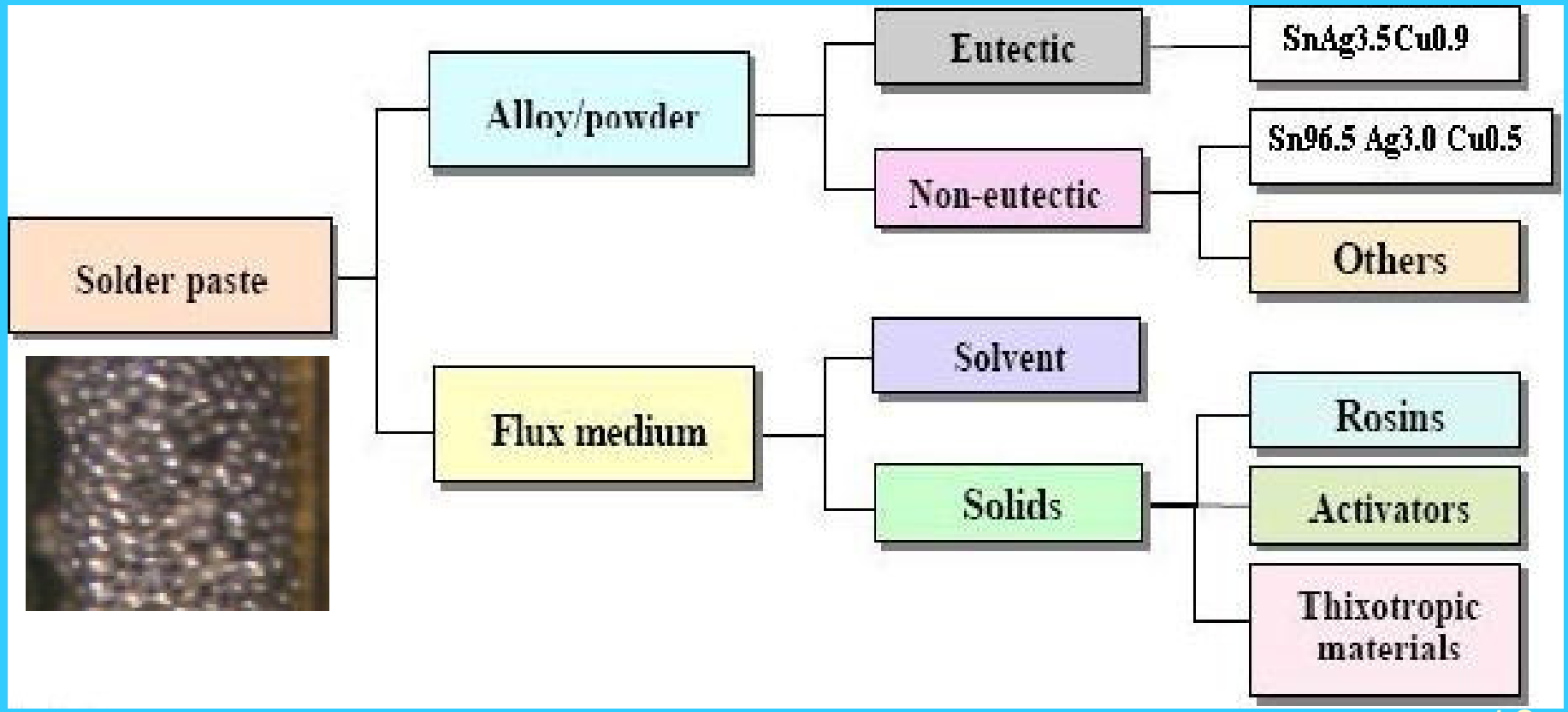
VPS PARAMETERS:

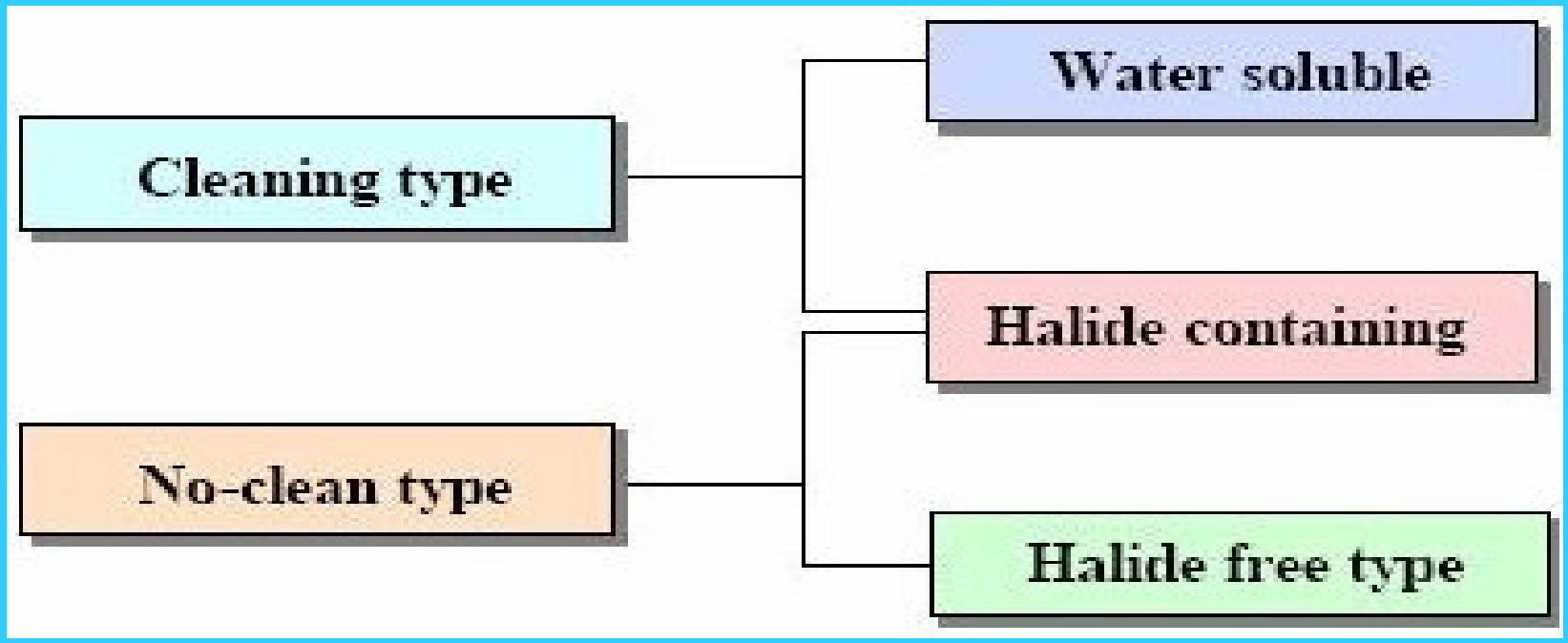
- **The level above boiling liquid surface;**
- **Duration on each programed level;**
- **Energy introduced in system.**

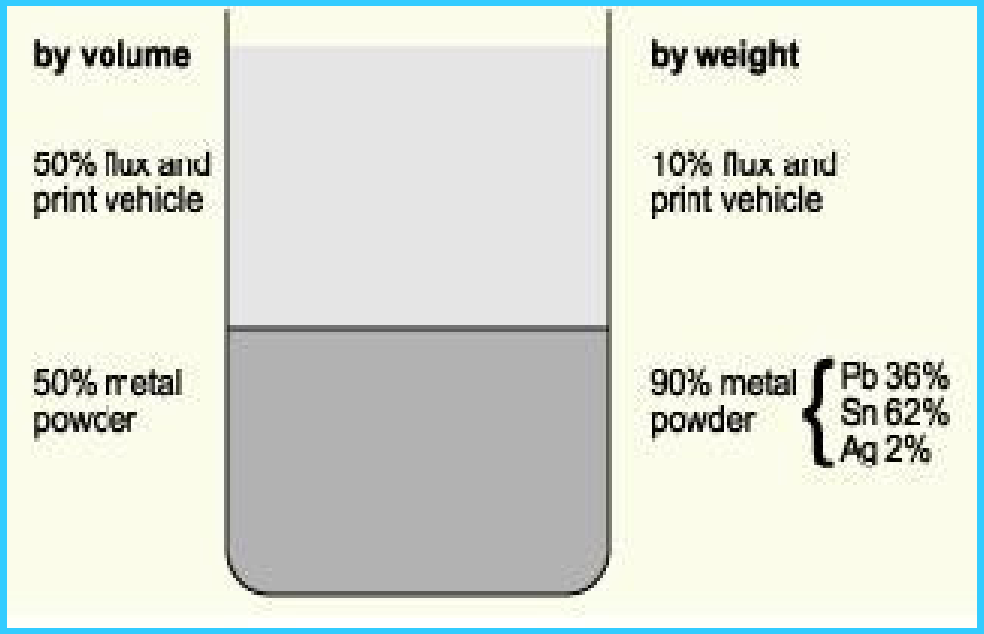
  (to boiling liquid)

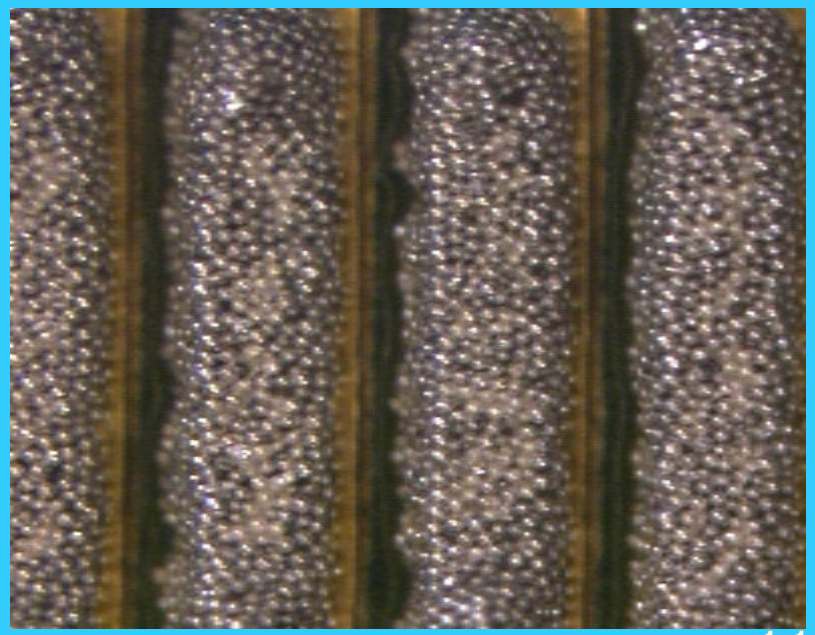
2. SOLDER PASTE PARAMETERS

Solder paste: - suspension of solder particles in a flux-containing printing vehicle in which the shape and size of the particles and the flow properties ('rheology') of the flux vehicle are matched to the method of paste application (printing process) in order to obtain the optimum deposit on pads corresponding whit components terminals, that are put on there (pick & place)




Cleaning type
No-clean type
Water soluble
Halide containing
Halide free type


by volume
50% flux and print vehicle
50% metal powder
by weight
10% flux and print vehicle
90% metal powder
Pb 36%
Sn 62%
Ag 2%



Solder particles size and distributions:

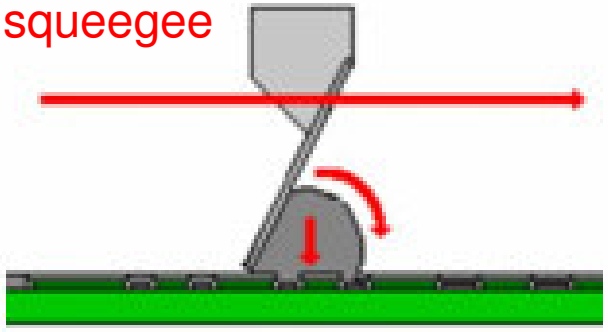
- standardized according with ANSI/J-STD-005 standard and IPC specification IPC-SF-819

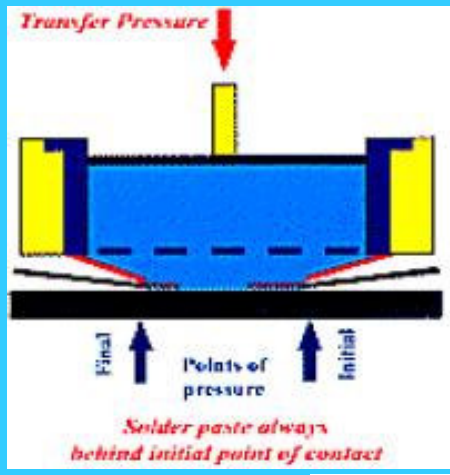
Solder particle powder size designation in ANSI/J-STD-005				
Type	<0.005% larger than	<1% larger than	>90% between	>10% smaller than
1	180µm	150µm	150-75µm	20µm
2	90µm	75µm	75-45µm	20µm
3	53µm	45µm	45-25µm	20µm
4	45µm	38µm	38-20µm	20µm
5	32µm	25µm	25-15µm	15µm
6	25µm	15µm	15-5µm	5µm

Solder paste characteristics:

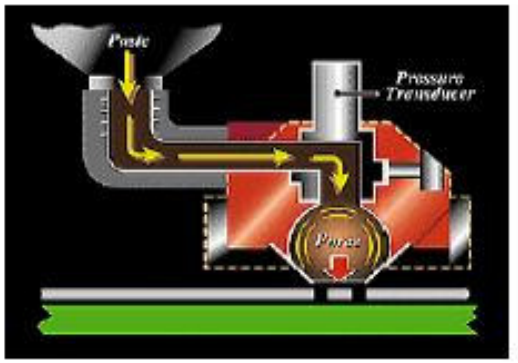
- **Flow; Thixotropy; Rheology : to assure print process**

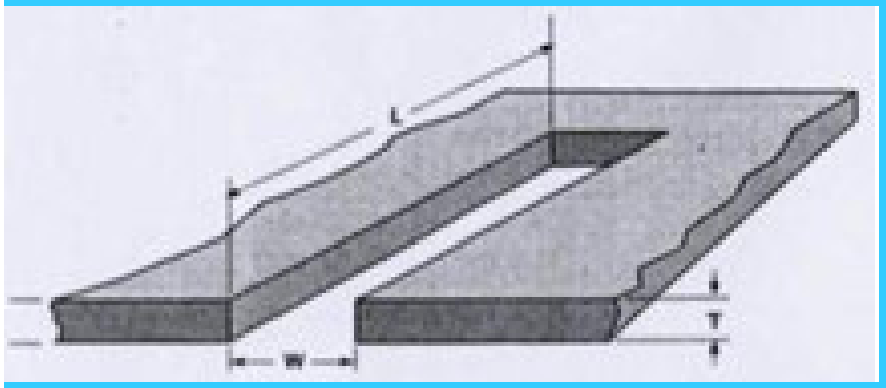
squeegee

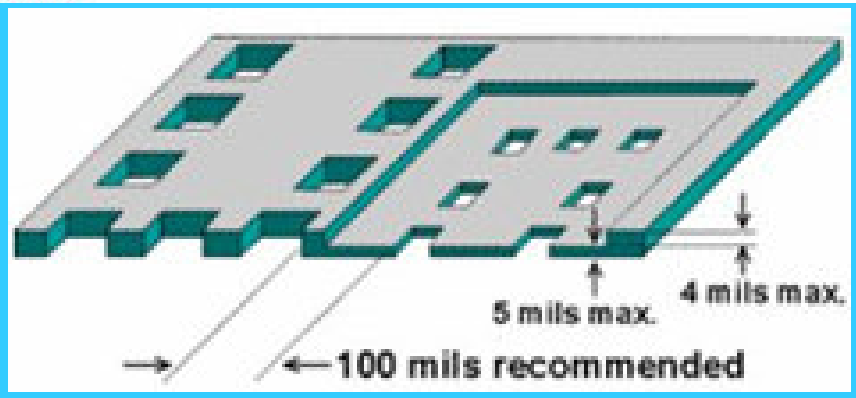


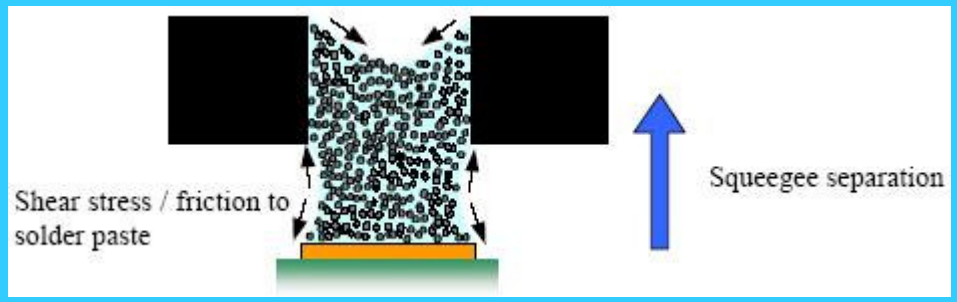


proflow

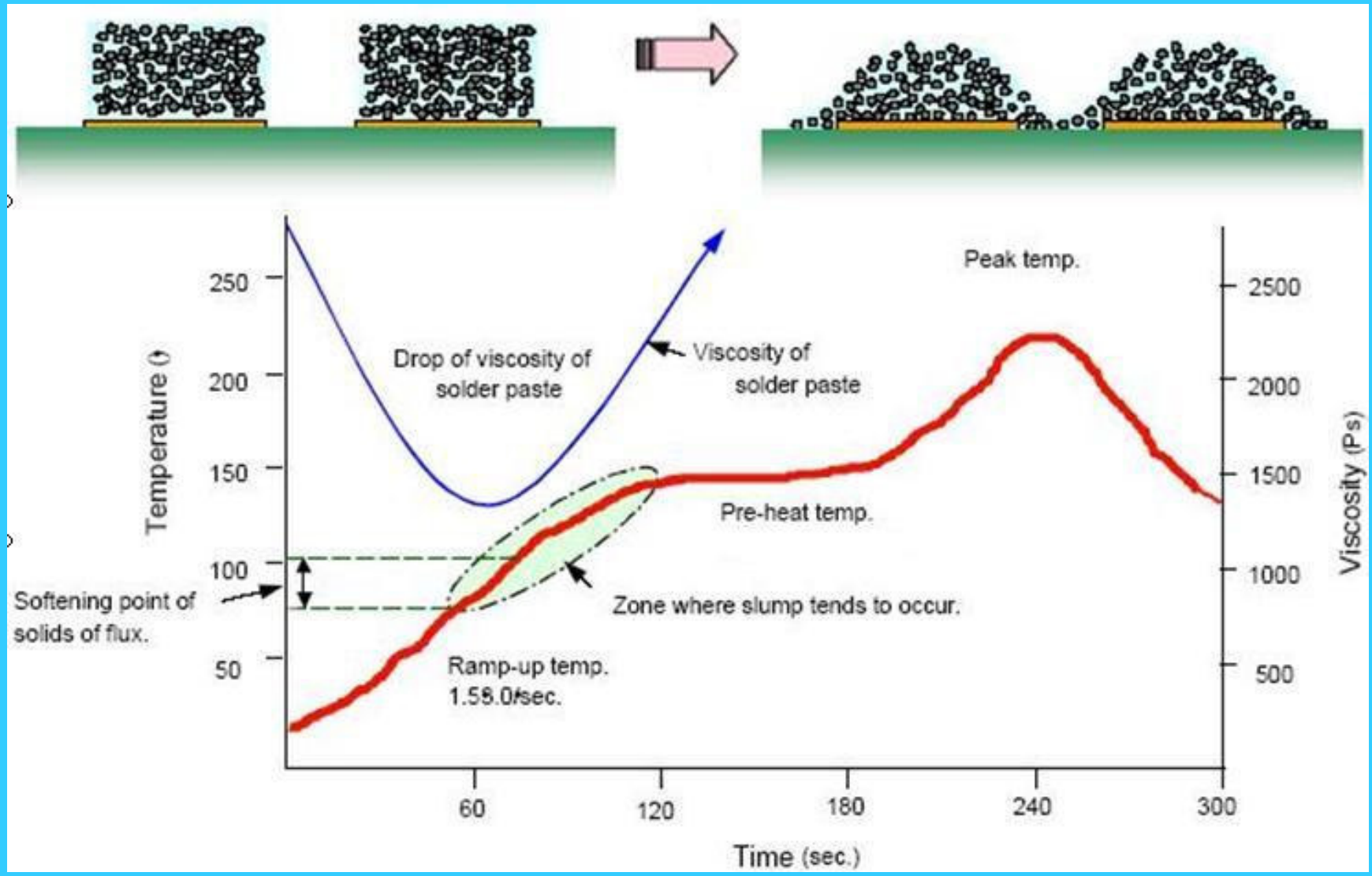


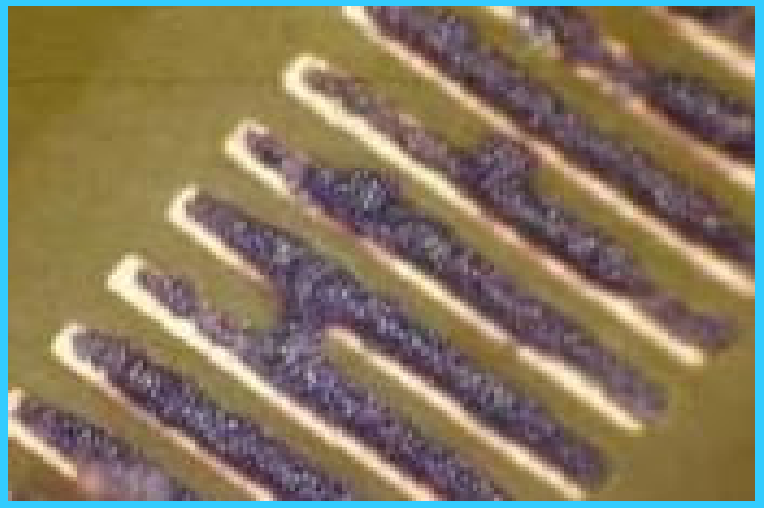


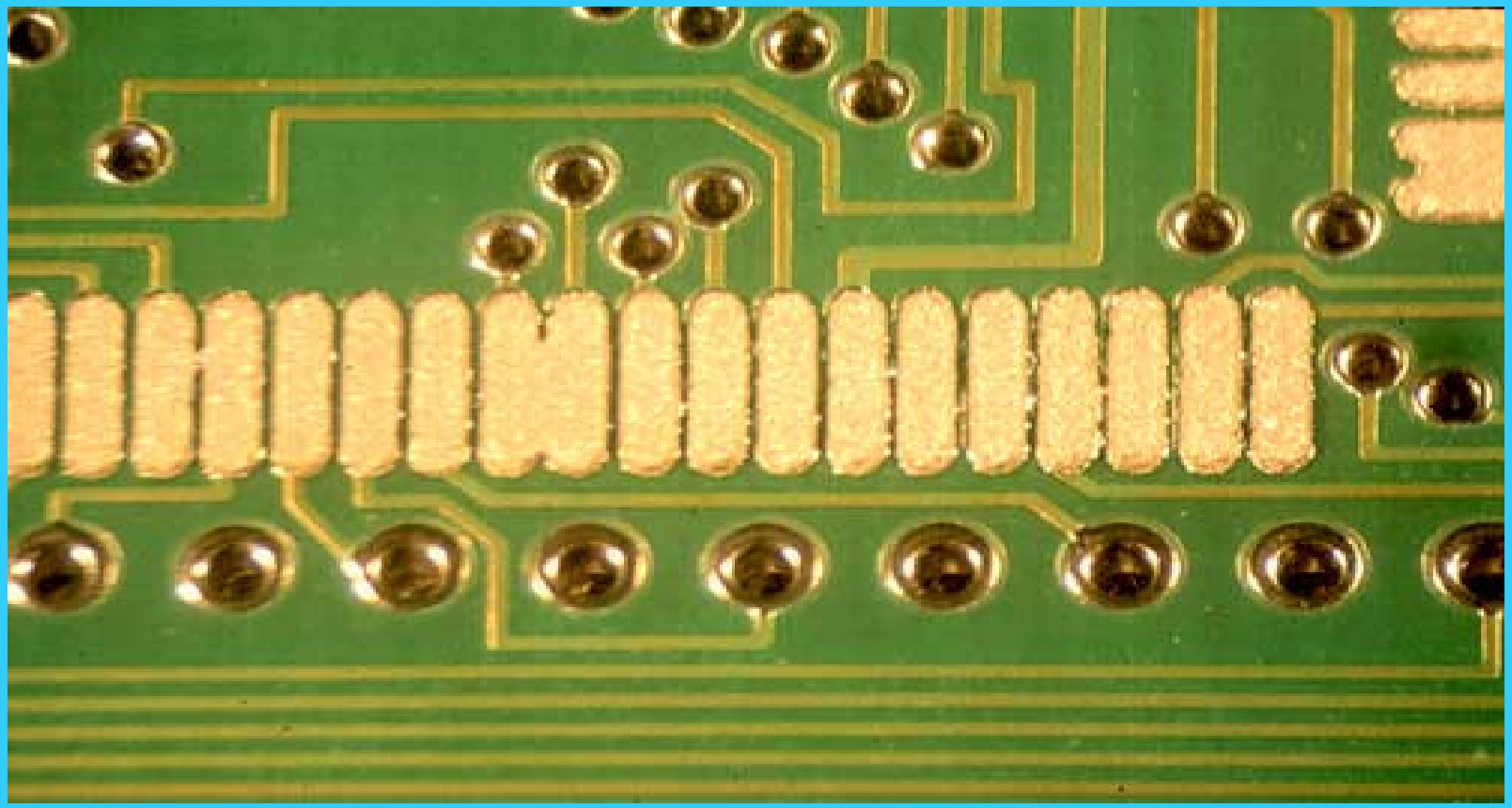




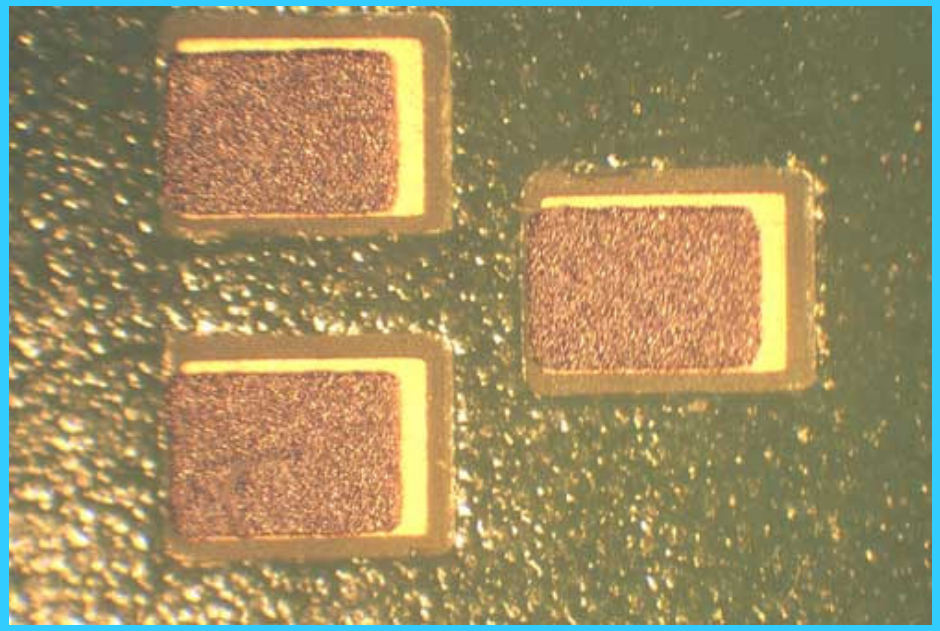
- **Slump: tends to slump and spread after printing or dispensing.**

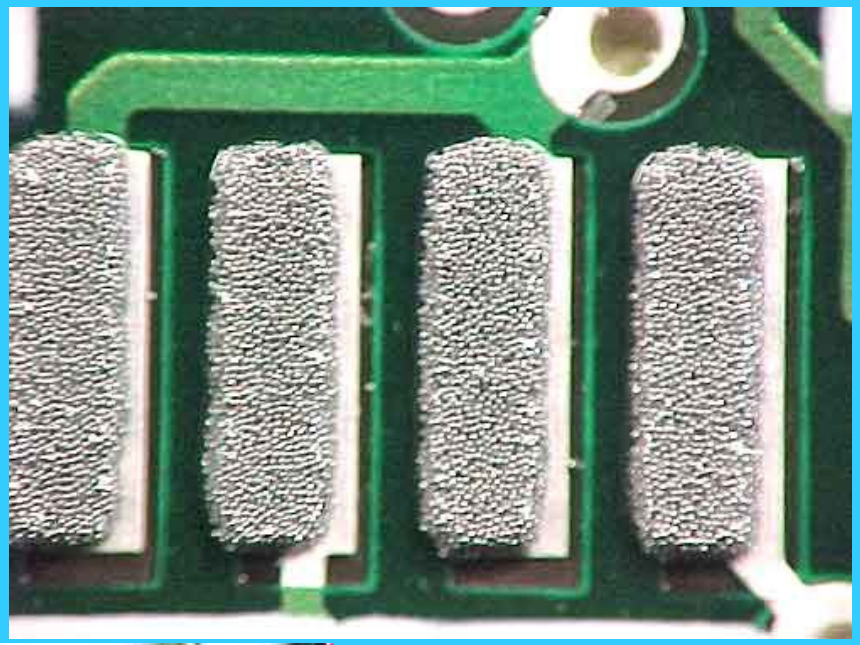


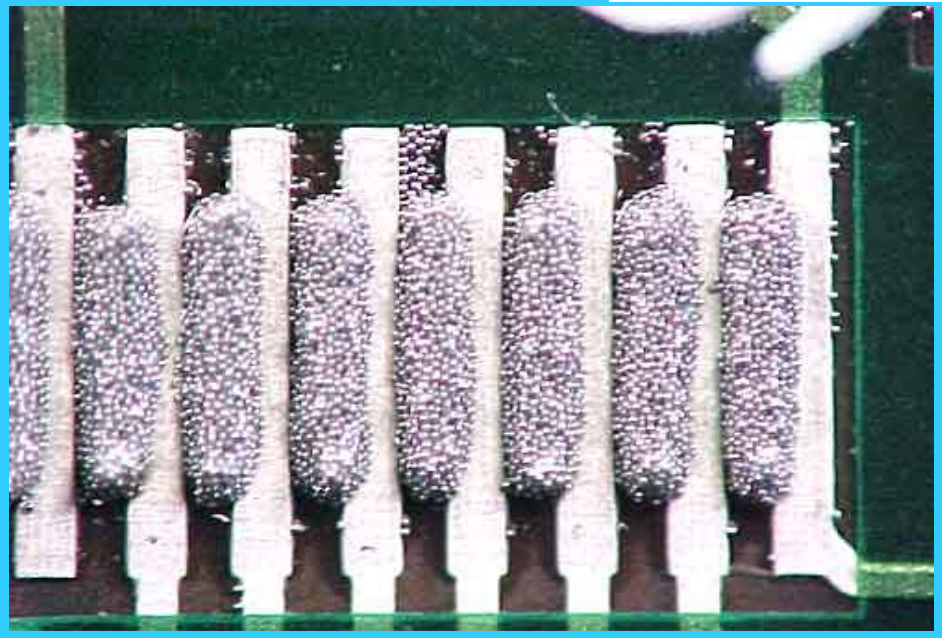




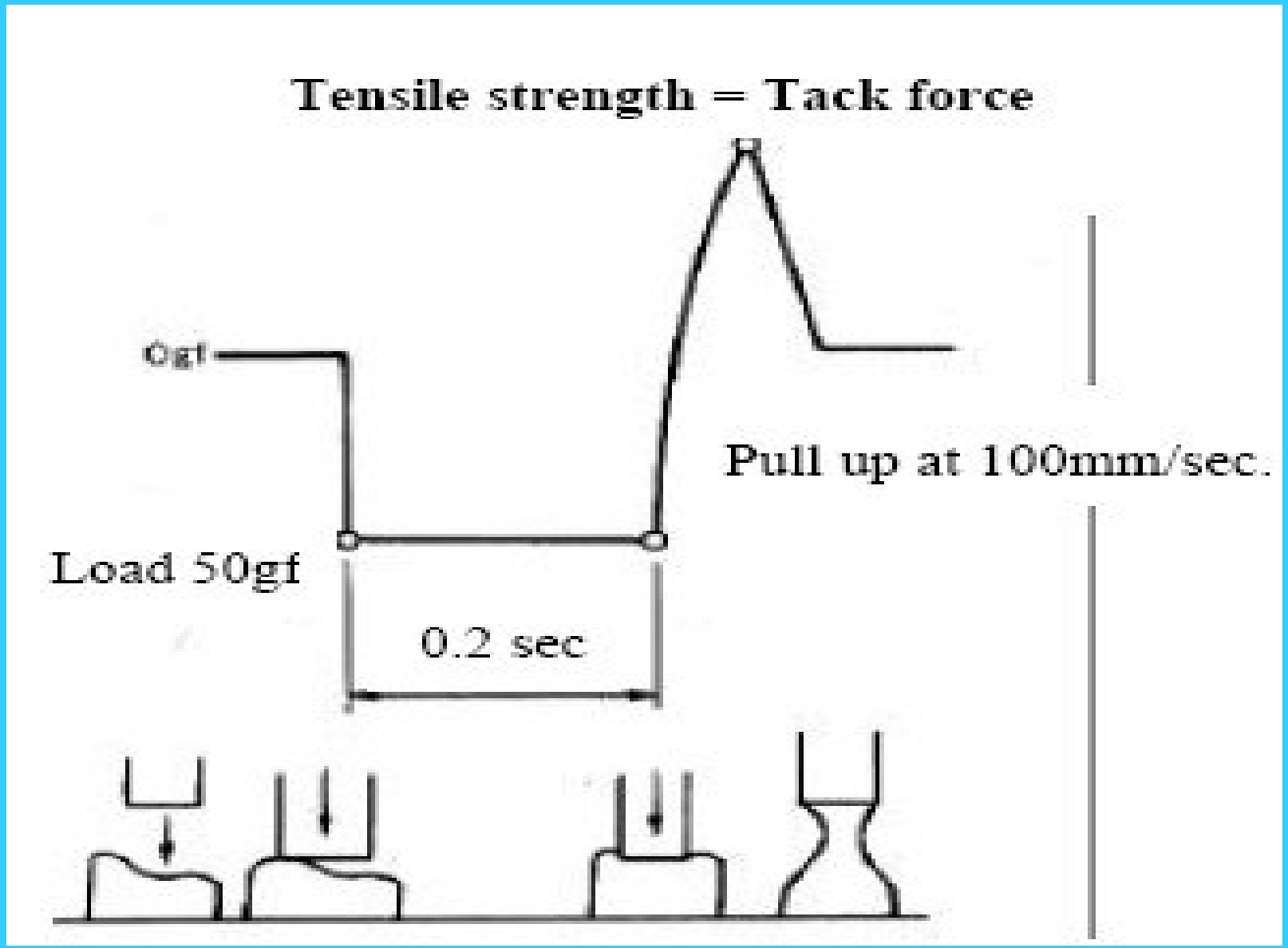
Solder paste misalignment & printing defects



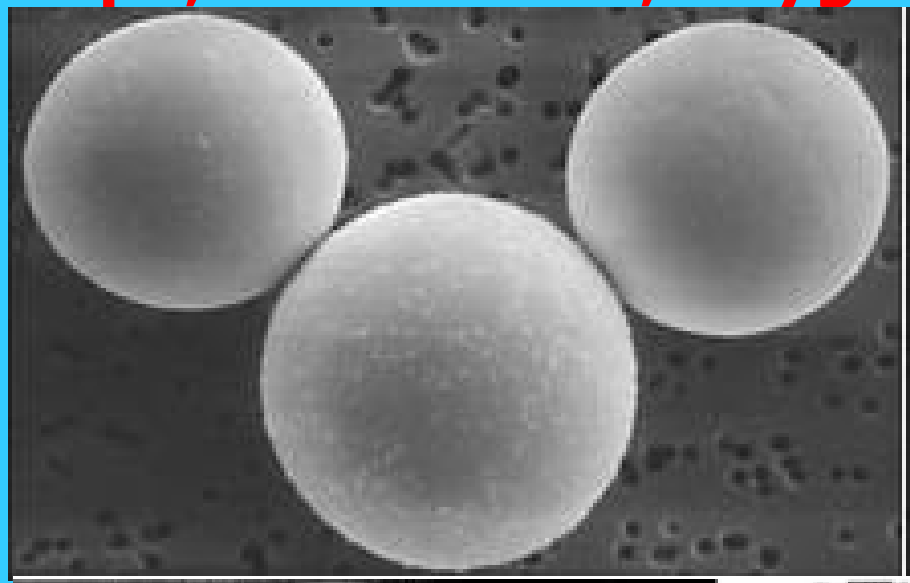


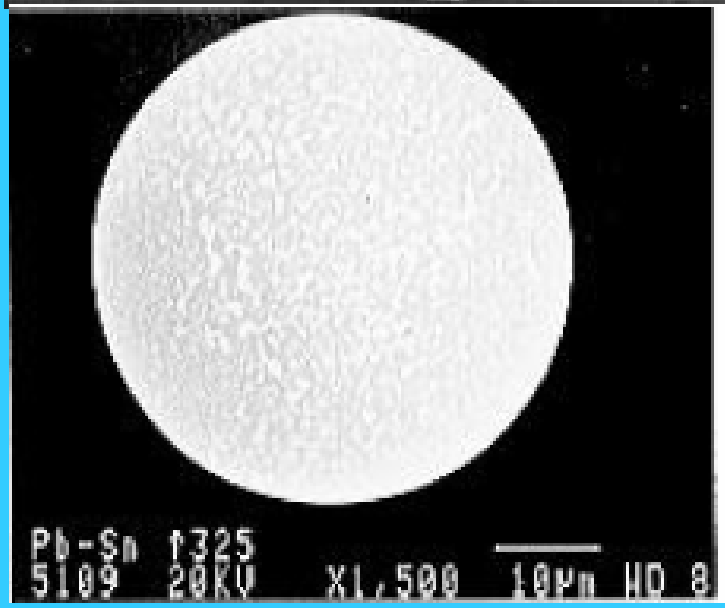


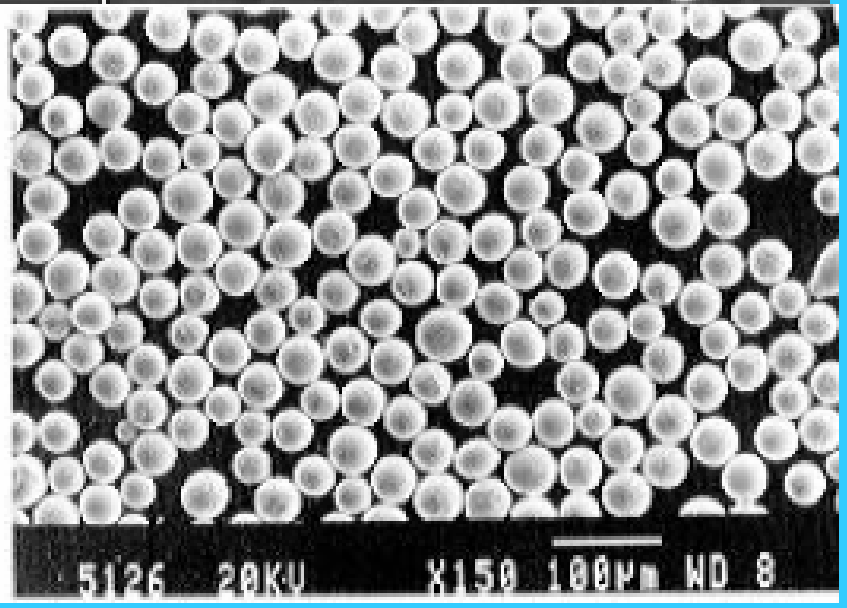
- **Tackiness: to enable the paste deposit to stick to components pressed into it.**



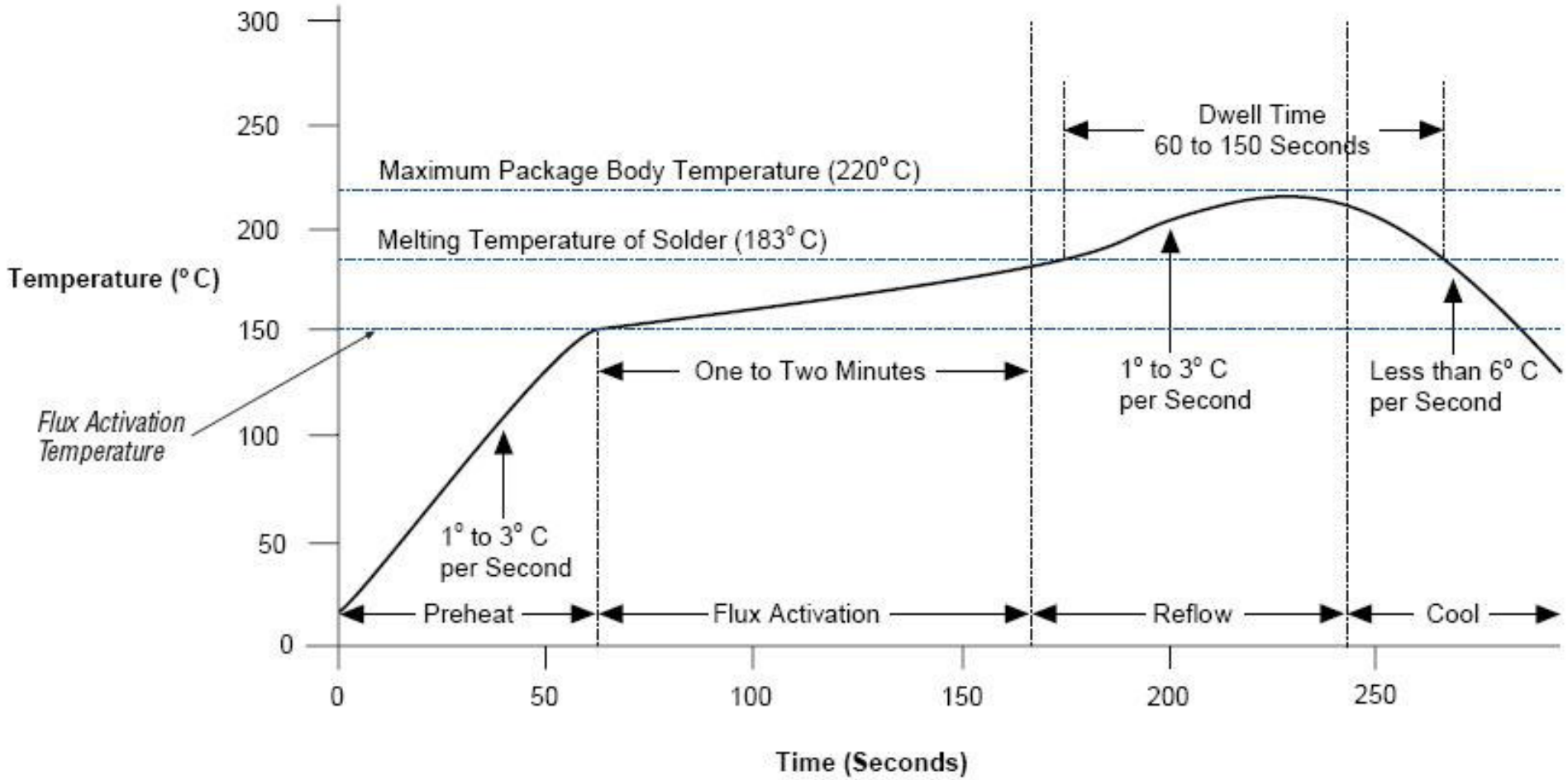
- **Metal content: solder alloy particle content, shape, dimensions, oxygen content.**







3. THERMAL PROFILE


300
250
200
150
100
50
0
Temperature (°C)
Maximum Package Body Temperature (220° C)
Melting Temperature of Solder (183° C)
Dwell Time
60 to 150 Seconds
Flux Activation
Temperature
One to Two Minutes
1° to 3° C
per Second
1° to 3° C
per Second
Less than 6° C
per Second
Preheat
Flux Activation
Reflow
Cool
0
50
100
150
200
250
Time (Seconds)

Lead free thermal profile limits

Lead-Free Reflow Profile Recommendation (IPC/JEDEC J-STD-020C)	
Reflow Parameter	**Lead-Free Assembly**
Minimum preheat temperature (Ts_{MIN})	150°C
Maximum preheat temperature (Ts_{MAX})	200°C
Preheat Time	60-180 seconds
Ts_{MAX} to T_L ramp-up rate	3°C/second maximum
Time above temperature T_L (t_L)	217°C 60-120 seconds
Peak Temperature (T_P)	
Time 25°C to T_P	6 minute maximum
Time within 5° of Peak T_P	10-20 seconds
Ramp-down rate	4°C/second maximum

Lead-Free Process - Peak Reflow Temperatures (TP)			
Package Thickness	**Volume mm3 < 350**	**Volume mm3 350-2000**	**Volume mm3 > 2000**
< 1.6 mm	260°C	260°C	260°C
1.6mm-2.55mm	260°C	250°C	245°C
>2.5mm	250°C	245°C	245°C

3. Experiment

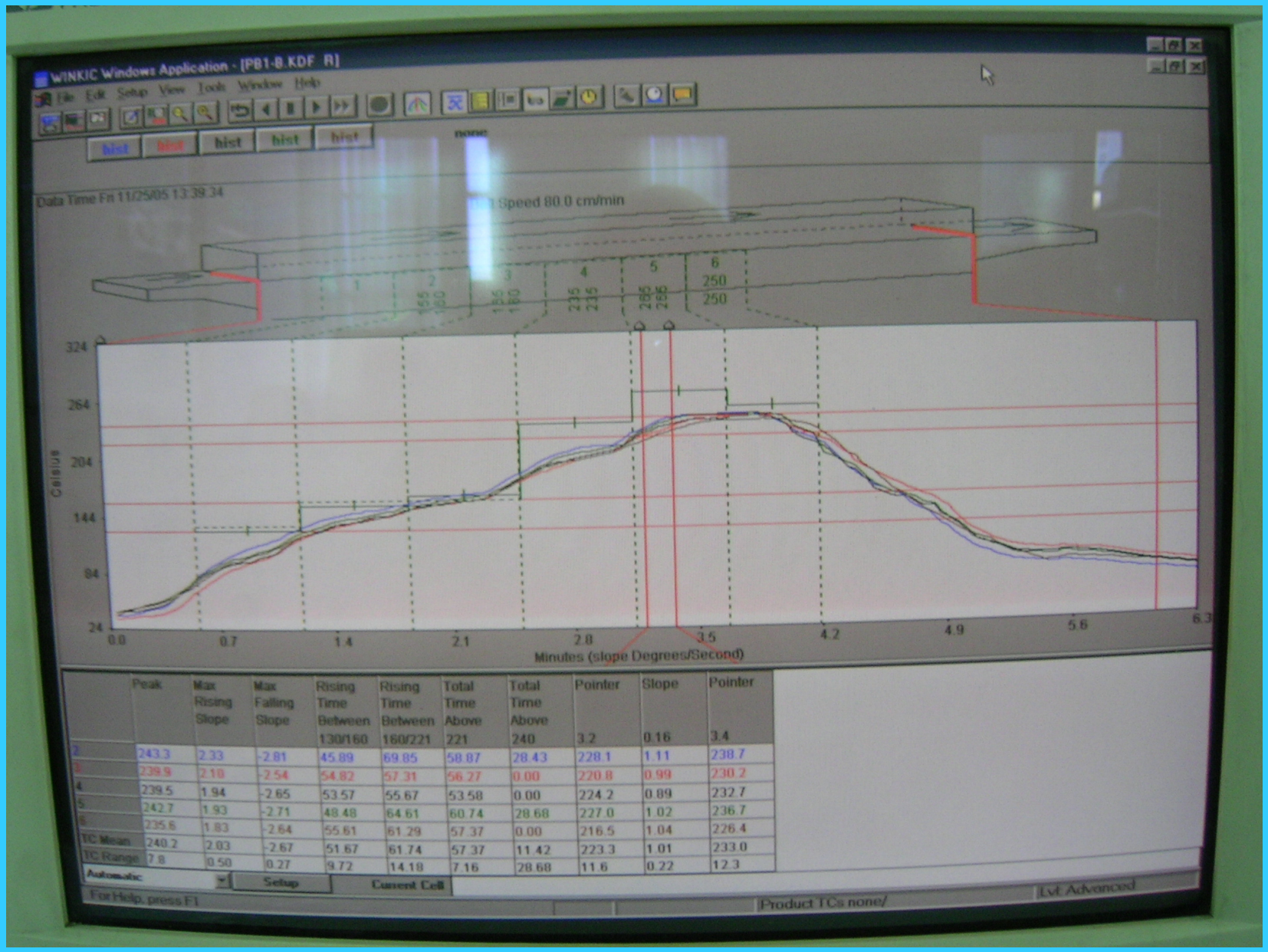
The goals of experiments:

- **IR/C Bandwidth and Shape of Profile;**
- **VPS thermal profile optimizations;**

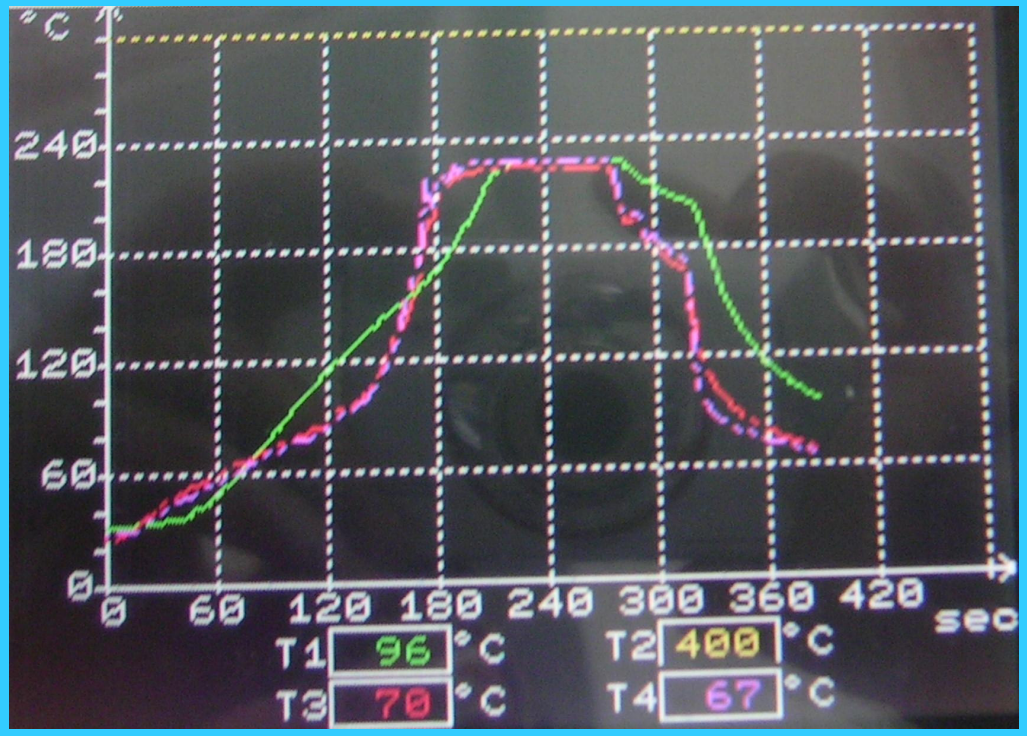
The experiment resources:

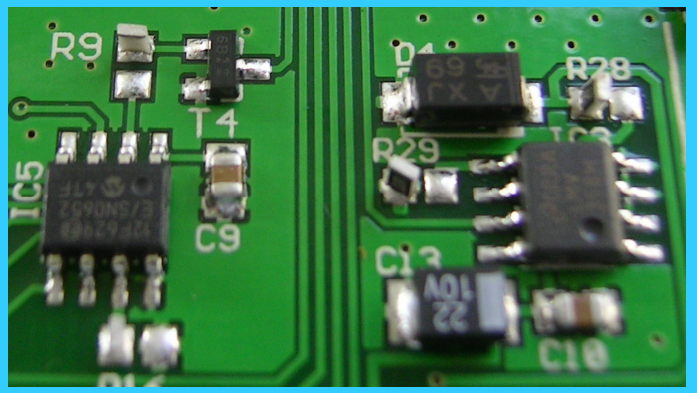
Solder paste: OM338T, no-clean, type 3,
(25-45µm per IPC J-STD-005)
SMT line: printer/DEK 265 Infinity,
pick-&-place/HSP 4796 GSM2-FlexJet
VPS machine: SLC504, IBL
Components: Chip cases 0402, 0603, 0805, 1206

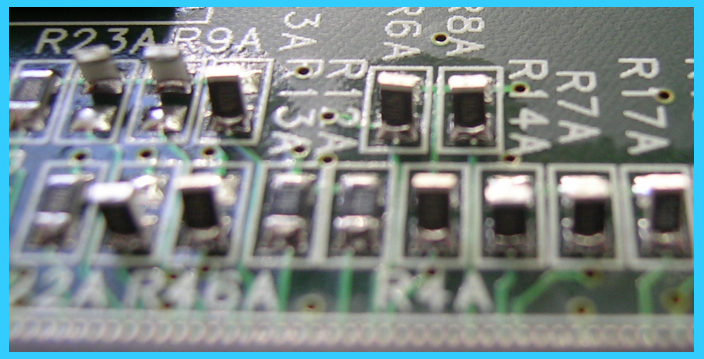
Bandwidth and Shape of Profile



VPS thermal profile optimizations







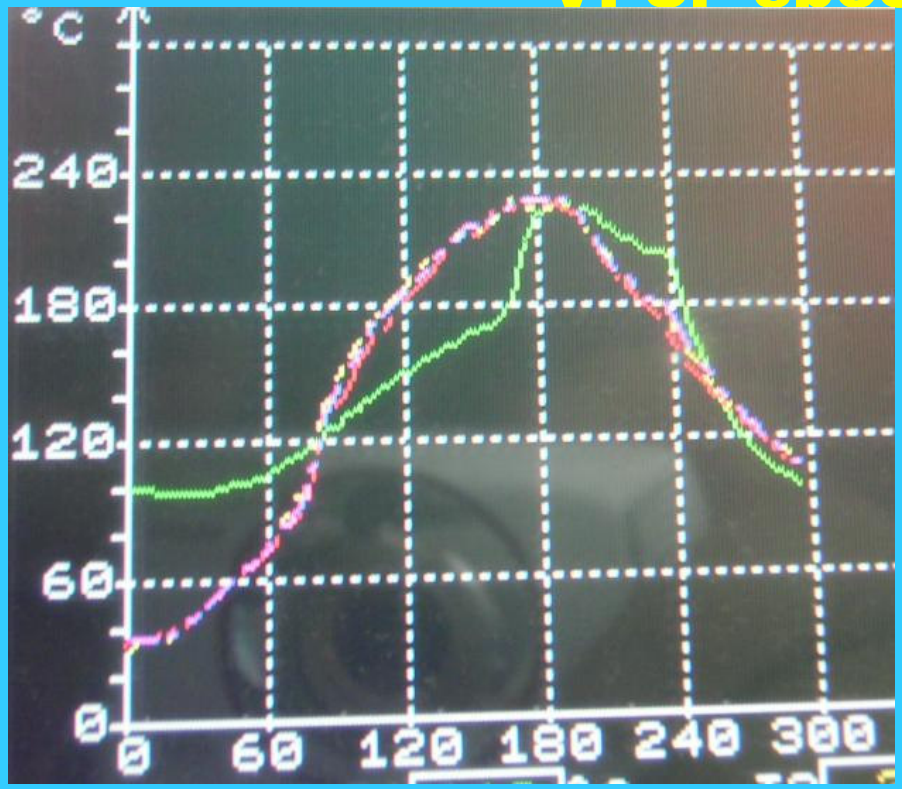
Results

Bandwidth: - IR/C: 10℃

- VPS: 3℃

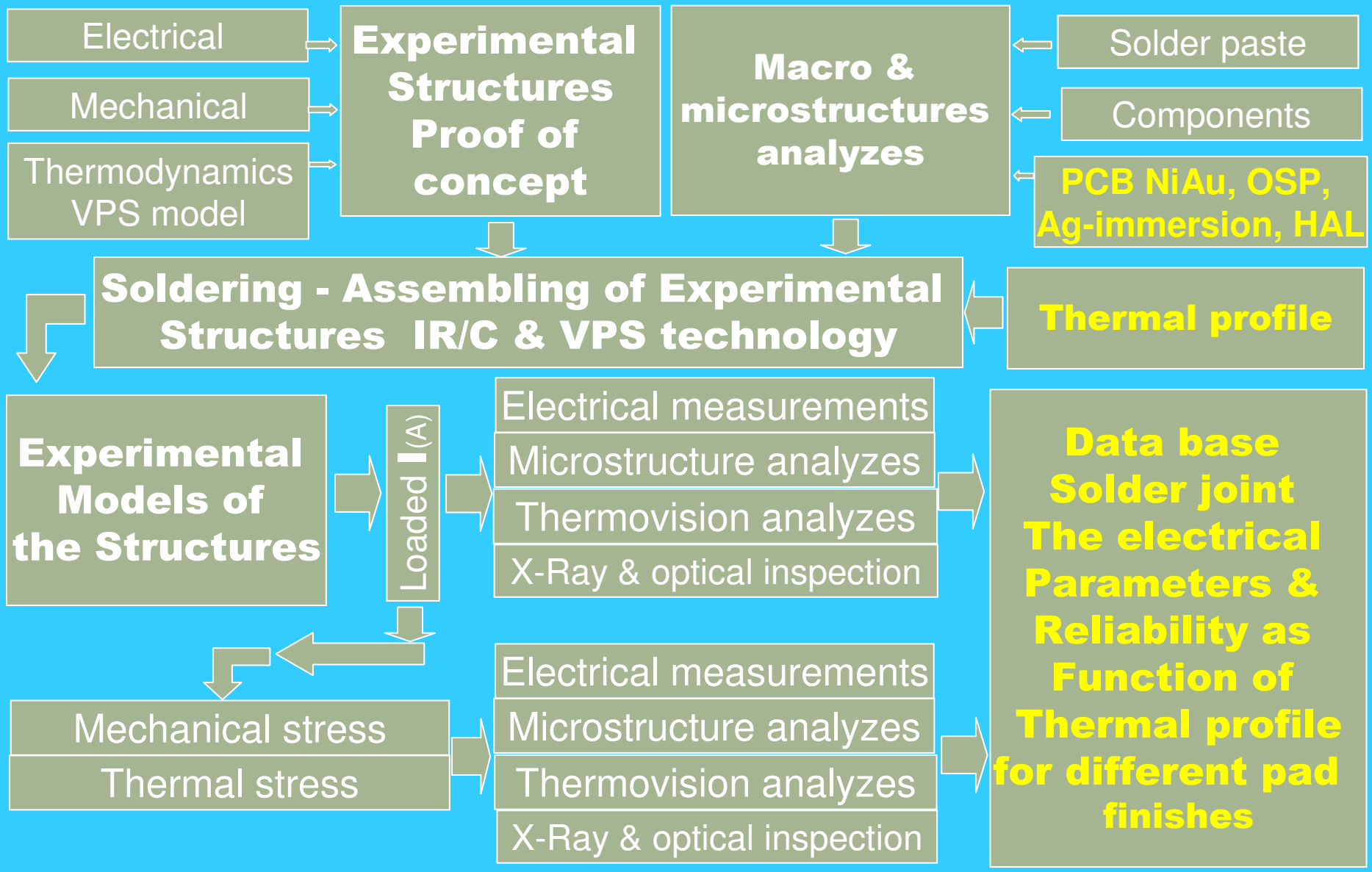
Shape: - IR/C: clasic, IPC /JEDEC- J-STD-020

- VPS: specific shape

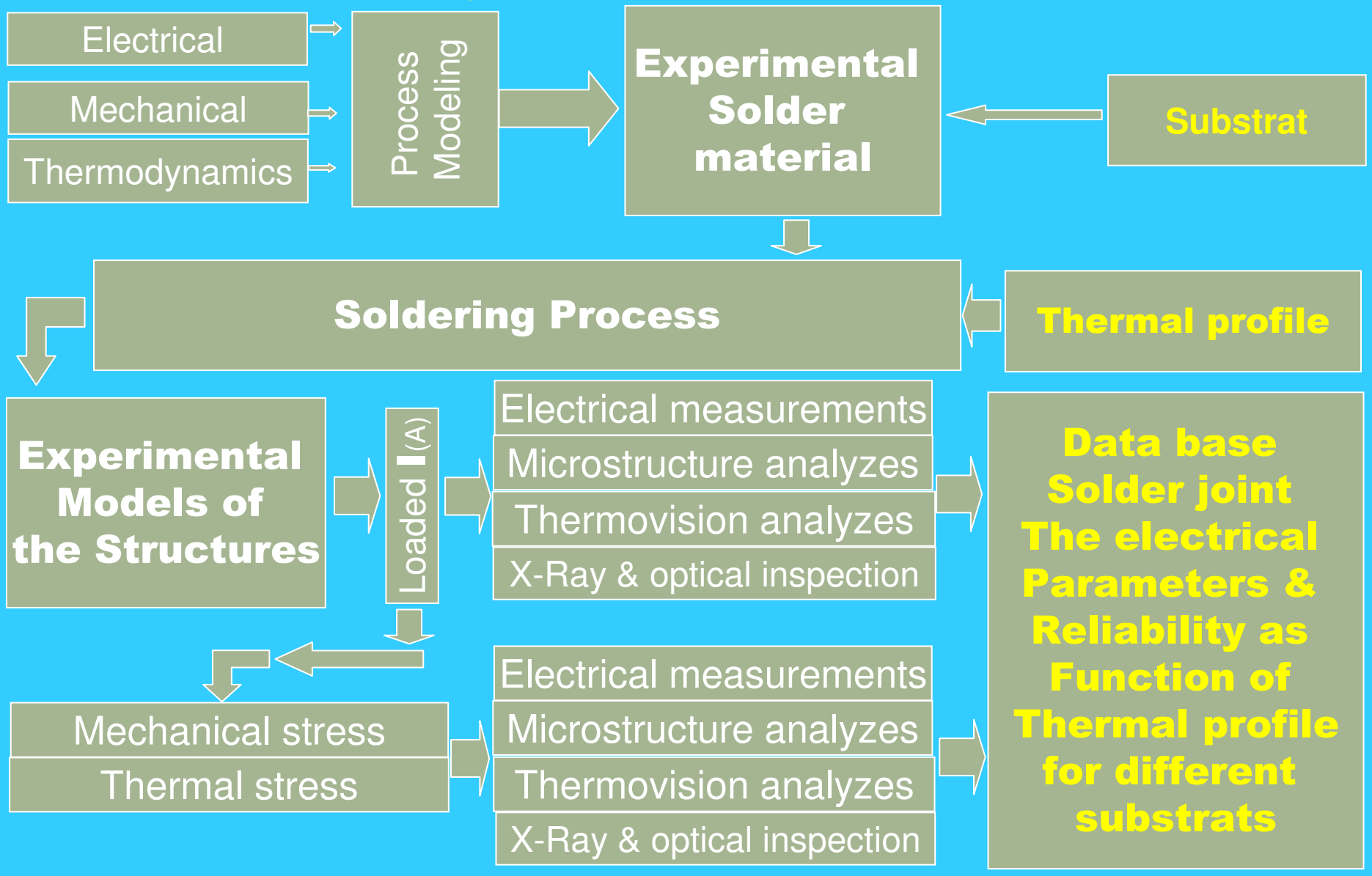


Process	Parameters		
Phase	Level	Power %	Period s
Step 1	10	50	25
Step 2	8	50	40
	4	50	2
	10	50	2
Solder Step	1	40	5
	2	90	1
	3	100	1
	4	80	5
Evaporate	Over	0	20
Cooling	Over	0	60

EOI – support project proposal Part I



EOI – support project proposal Part II



Partners:

- Departement of Material Science and Physical Metallurgy - Associated. Prof. Mihai Branzei - solder pastes and solder joints microstructures analyse;

- Research Center for Applied Mechanic – Prof. Dan Constantinescu - mechanical properties of solder joint determination;

- Research Center for Energy and Environment Protection, Prof Corneliu Balan - Rheology, Thermodynamically properties;

-OEM/EMS companies in assembling of electronic equipments field INTRAROM – COO Carmen Turcu - reflow process applications;

-Fela Romania technology SCS – CEO Alexandru Batuca – PCB's manufacturing

Conclusions

- VPS opportunity for Zn based sollder alloy

- The optimum VPS thermal profile by measuring temperatures directly on pcb surface:
  - preheating with 1.4 ℃/sec until 185-190℃ and go to range of melting point with 0.66 ℃/sec until maximum temperature 230 ℃.

THANK YOU !