Hot nitrogen for wave soldering

A new innovation for increasing quality & productivity of wave soldering machines

Laurent Coudurier* – Fernand Heine* – Didier Orlhac**
*Air Liquide technology center / Krefeld - Germany
** Air Liquide IM-T&R markets / Paris - France

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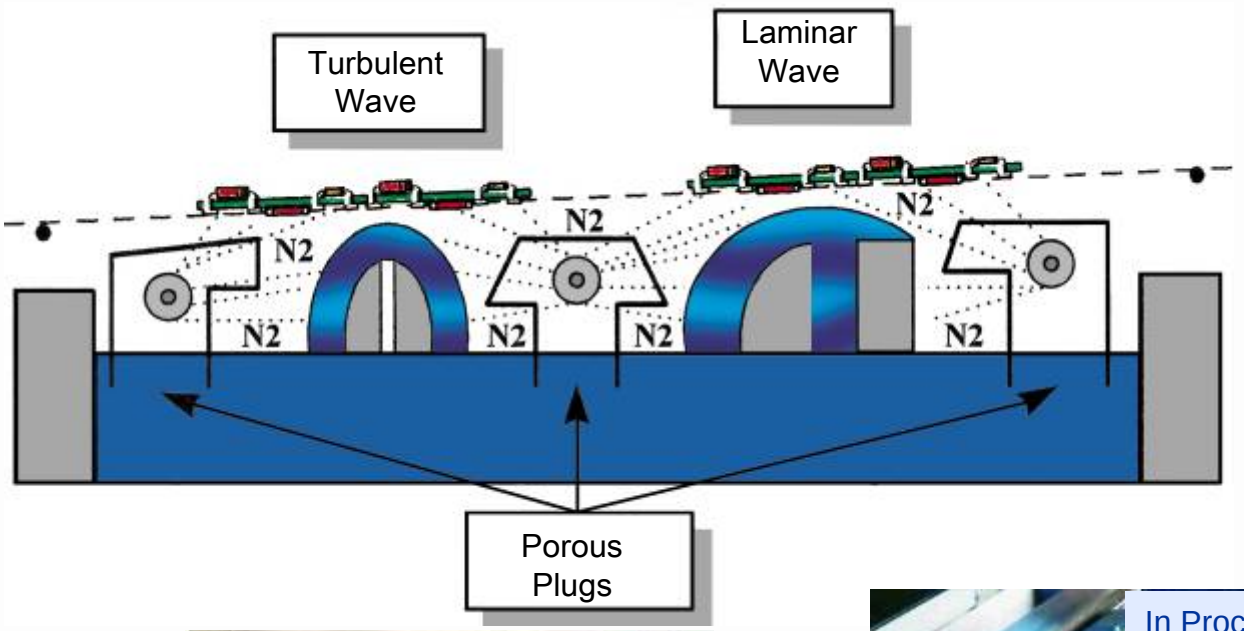
- Local Nitrogen inerting system
- Important operating parameters
- Why preheat N2 ?
- How to preheat N2 ?
- Impact on soldering quality - fields results
- Conclusions

Wave soldering - Background situation

- Main solder alloys for Tin Lead substitution
  - ✓ SAC 305, SAC 405, SN100C, SACX 0307, Sn99.3Cu0.7
- Solder pot temperature : 250 - 265° C
  - ✓ Solder melting temperature: 183 -217° C (SAC 305)
- Inert atmosphere now becomes very common, and is recommended by the main OEMs
  - ✓ Better wetting
  - ✓ Less dross
  - ✓ Use of less actives fluxes, and less flux consumption
  - ✓ Higher reliability and reproducibility
  - ✓ Less maintenance
- Inerting technologies for waves soldering machines:
  - ✓ Full tunnel
  - ✓ Local inerting system (original equipment or retrofit)

Typical layout of a local Nitrogen inerting system

System showed:
ALIX Inertwave equipment -
Air Liquide



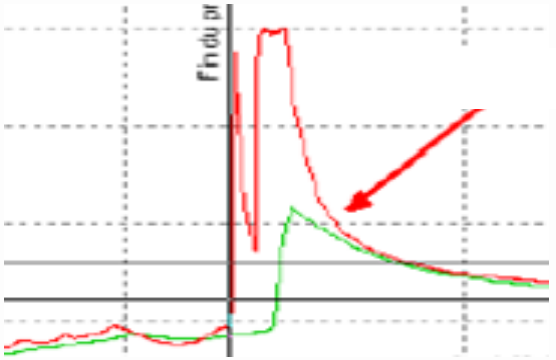
Titanium Frame

N2 flow control Panel

In Process

Important parameters for wave soldering

- Heat transfer and contact time between solder alloy and PCB
  - ✓ 2 most important criteria for quality of soldering joints
- All other operating parameters have to be set accordingly:
  - ✓ Preheating and solder bath temperatures, wave nozzles geometry, rotating speed of the pumps, conveyor speed
- Need to increase heat-transfer and contact time on PCBs
  - ✓ Why? Lead free solder and massive PTH components
  - ✓ Possible solutions:
    - ✓ Reduce conveyor speed
    - ✓ Increase overall length of solder nozzles geometry (laminar wave) : limited effect !
  - ✓ Temperature drop between the 2 waves is critical
    - Intermediate solidification of the solder joints
    - Possible increase of intermetallics layer

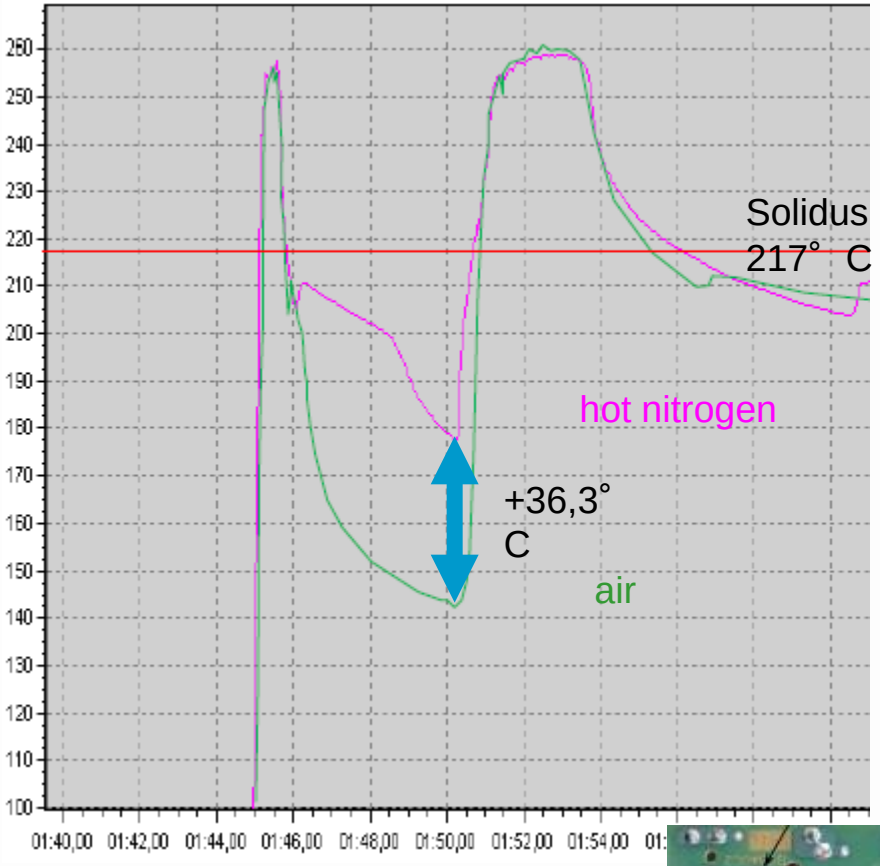


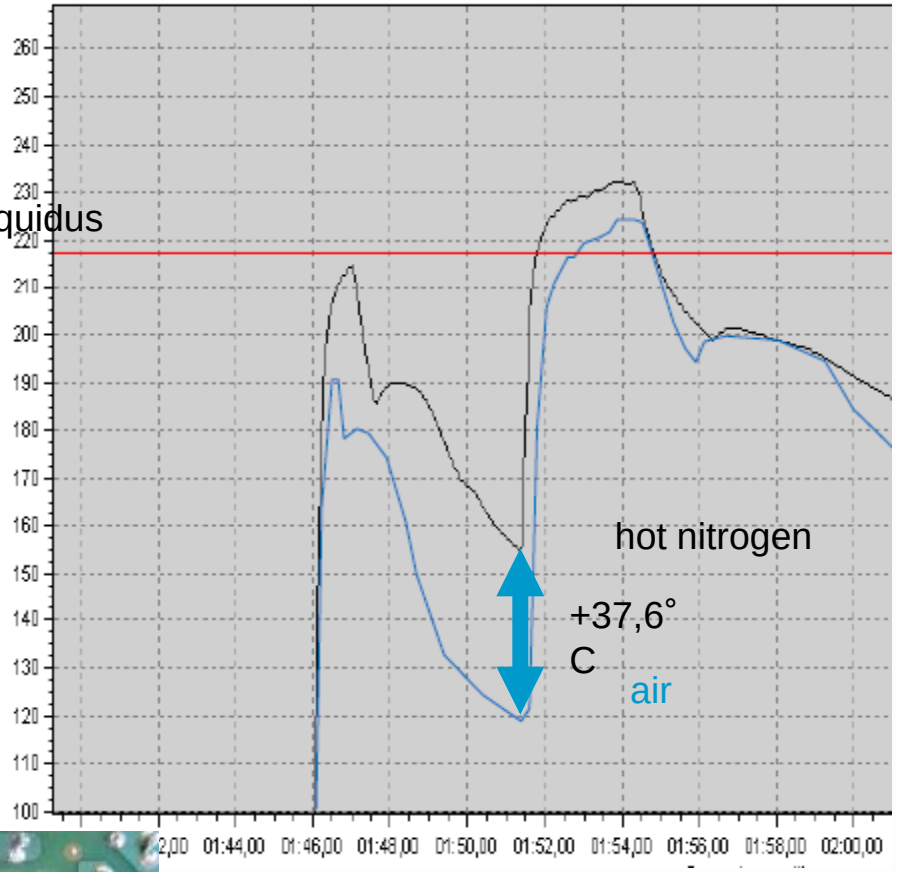
Why preheat nitrogen ?
1st reason

- Increase heat transfer and contact times
  - ✓ Thanks to the convection effect given by hot nitrogen, the temperature drop between the 2 waves is reduced
    - solder joints remain at higher temperature between the two waves.
  - ✓ And the equivalent contact time* is longer
    - The conveyor speed can be increased (higher production capacity)
    - Defects rate is reduced significantly
    - The solder joints quality is increased

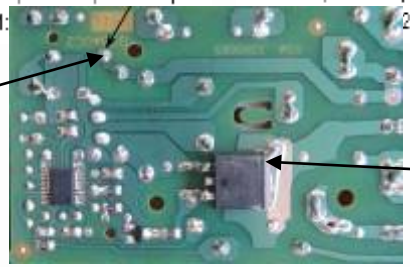
(* Time above liquidus temperature)

Temperature profiles



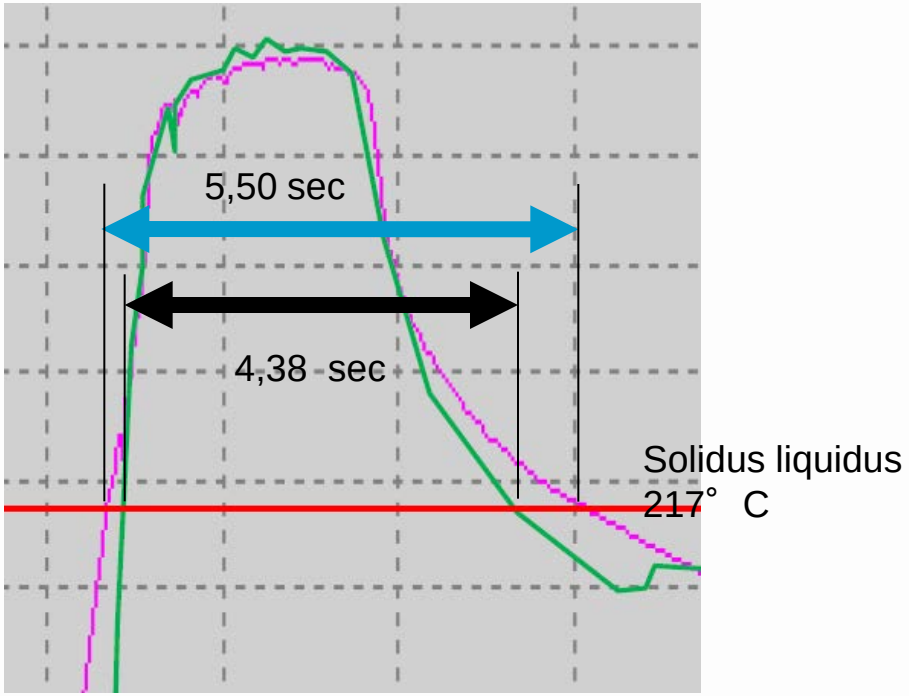


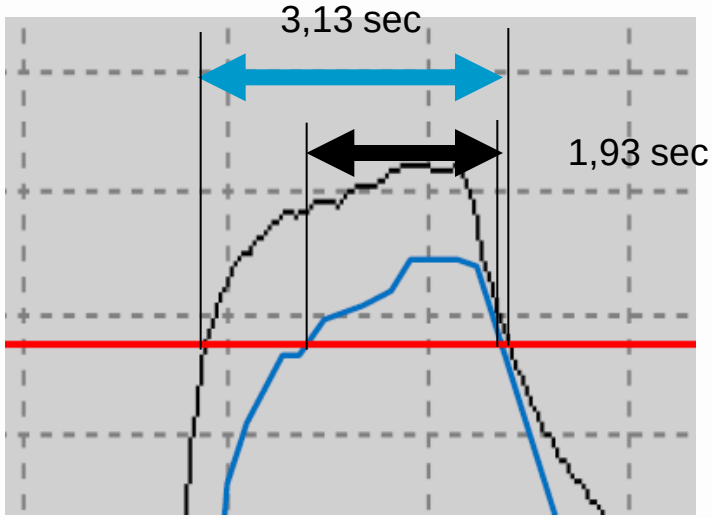
Temperature measurement on small diode pin



Temperature measurement on triac SMD

Equivalent contact times





Temperature measurement on small diode pin
(+ 25% equivalent contact time)

Temperature measurement on triac SMD
(+ 60% equivalent contact time)

(conveyor speed: 1,30 m/min)

Why preheat nitrogen ?
2nd reason

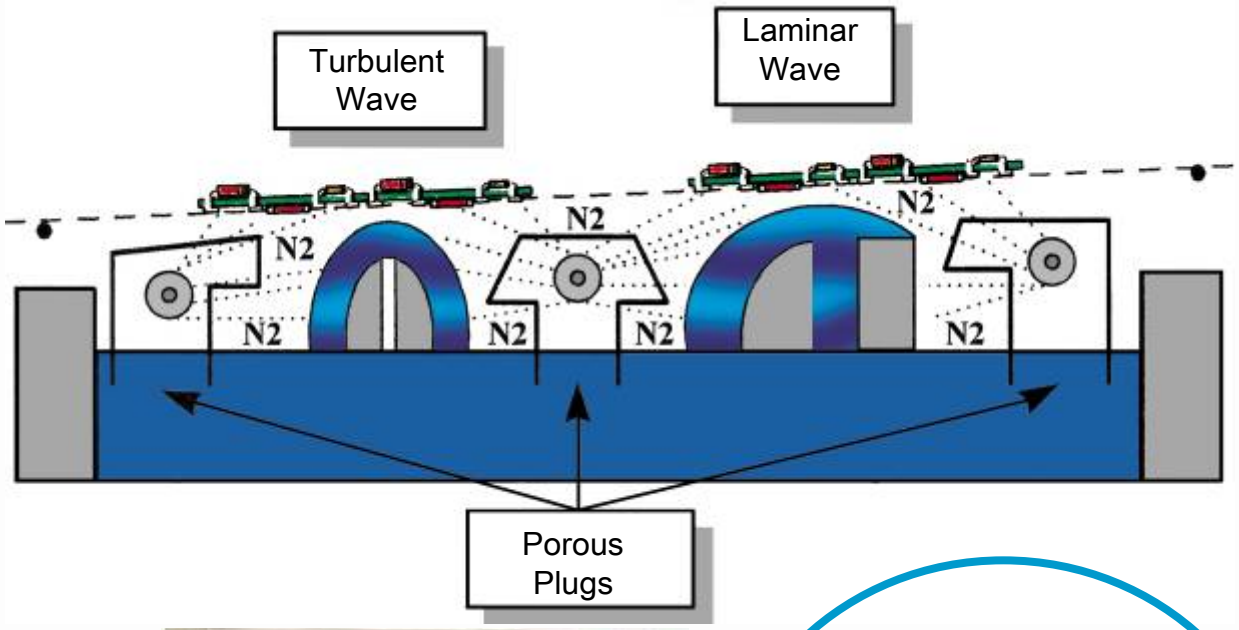
- Reduce maintenance
  - ✓ avoid clogging of the N2 diffusers
    - High speed of the pumps for powerful solder flow due to the mask technology (selective soldering).
      Solder is often over flowing and can easily hit the surroundings and solidify on the N2 diffusers
    - With hot Nitrogen, the solidification can not occur
  - ✓ avoid condensation of flux vapors on the N2 diffusers

How to preheat nitrogen ?

- A heat exchanger is necessary:
  - ✓ Use the enthalpy of the solder pot is easier and less expensive than an external heating
  - ✓ N2 temperature must reach at least the solidification temperature of the solder alloy (217° C for SAC305 – 227° C for Sn100C)
  - ✓ Possible to reach nitrogen temperature of 230° C.
  - ✓ Design is adapted to the machine geometry and available space

Hot nitrogen for local N2 inerting system - principle

System showed:
ALIX Inertwave equipment -
Air Liquide



Titanium Frame

N2 flow control Panel

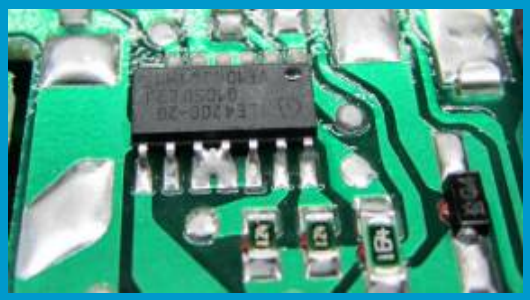
N2 heat-exchangers

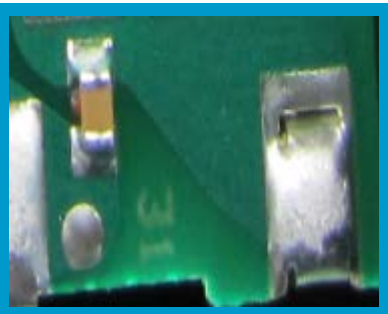
Example of implementation

Impact of hot Nitrogen on soldering quality

- Case 1 : power supplies - Lead free

	Cold nitrogen local inerting	Hot nitrogen local inerting	Delta
Defects total	793 dppm	522 dppm	- 34%
missing solder	364 dppm	183 dppm	- 50%
bridges	277 dppm	183 dppm	- 34%
icicles	41 dppm	43 dppm	+ 5%
others	111 dppm	113 dppm	+ 2%
Dross			- 10%
N2	18 Nm3/h	18 Nm3/h	0 %

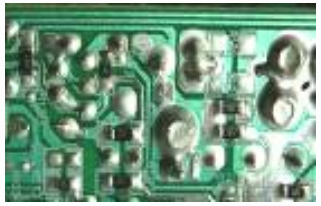





Impact of hot Nitrogen on soldering quality

- Case 2 : power supplies for computer - Lead free

	Reference	Hot nitrogen local inerting	Delta
PCB A - Defects total	1765 dppm	1247 dppm	- 30%
missing solder	665 dppm	477 dppm	- 28%
shorts-bridges	950 dppm	640 dppm	- 33%
Total PCB joints	147420	68880	
PCB X - Defects total	6313 dppm	3297 dppm	- 48%
missing solder	2512 dppm	386 dppm	- 85%
shorts-bridges	3756 dppm	1949 dppm	- 48%
Total PCB joints	86800	157 850	
Dross	0,4 kg/h	0,03 kg/h	- 93%
N2	-	19 Nm3/h	



Impact of hot Nitrogen on soldering quality

- Case 3 : EMS - data center I/O connectivity products - Lead free

	Reference	Hot nitrogen local inerting	Delta
Defects	8900 dppm	2600 dppm	- 67%
Dross	1.5kg/hr	0.06kg/hr	- 96%
Flux	1.16kg/hr	0.78kg/hr	- 33%
N2	-	17.2Nm3/hr	

Conclusions

- Hot nitrogen technology for local inerting system of wave soldering machines has proved to give significant advantages with Tin Lead or Lead free solders:

  - ✓ Better heat transfer on the PCBs, especially between the 2 waves (very important for lead free)
  - ✓ Longer equivalent contact time (up to +60% for massive components), allowing a higher conveyor speed
  - ✓ Better soldering quality, less joints defects: average -40% (up to -80% in some cases)
  - ✓ Almost maintenance-free system: no solder clogging and no flux vapors residues on the N2 diffusers (cleaning effect)

- Already more than 100 field references with ALIX Inertwave HT system of Air Liquide (patent apply for design)