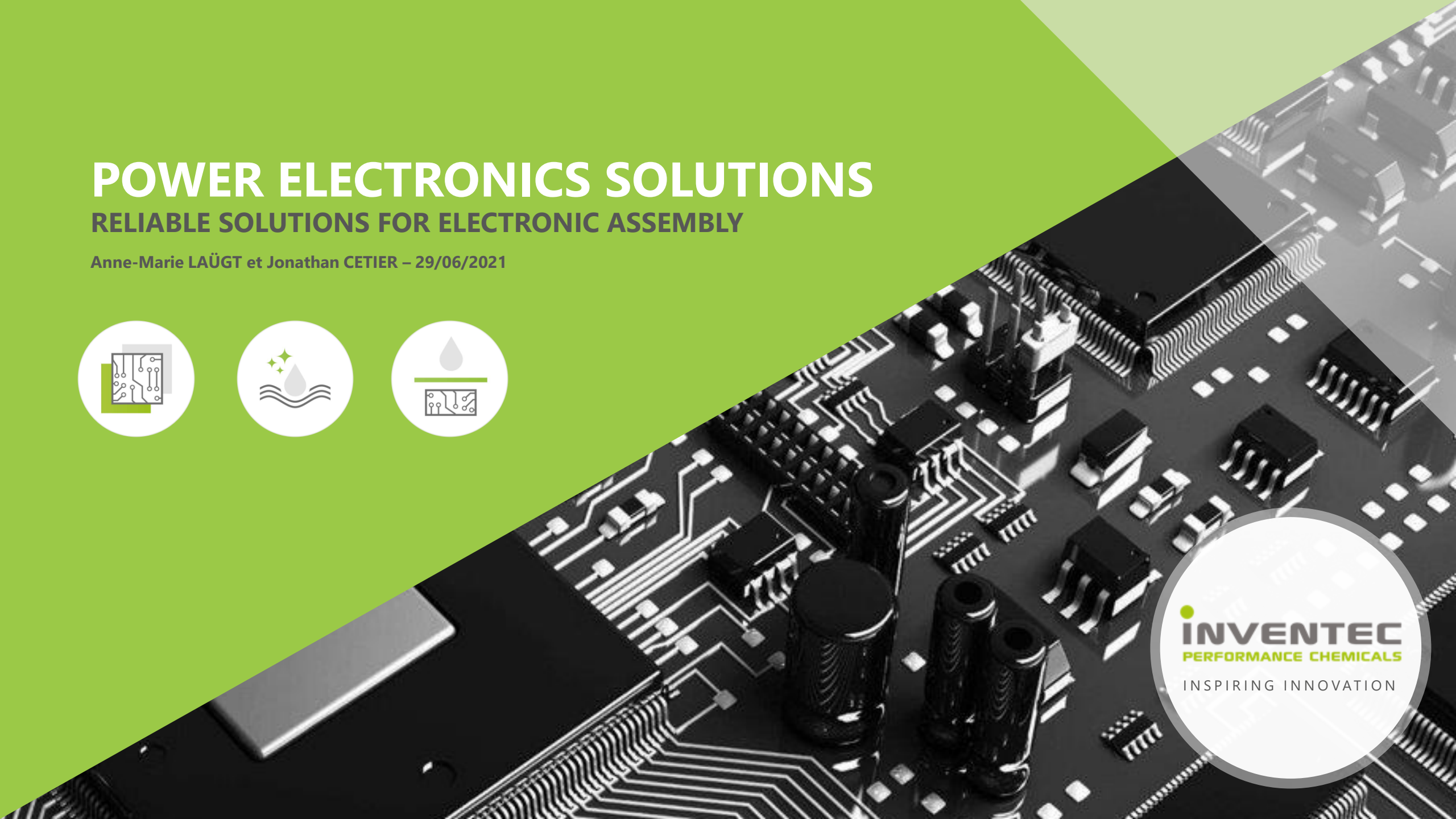
POWER ELECTRONICS SOLUTIONS

RELIABLE SOLUTIONS FOR ELECTRONIC ASSEMBLY

Anne-Marie LAÜGT et Jonathan CETIER – 29/06/2021



INVENTEC
PERFORMANCE CHEMICALS
INSPIRING INNOVATION

INVENTEC IN THE DEHON GROUP

A family owned company created in 1874, first specialized in the filling and distributon of refrigerants.

- HQ : Paris, France
- 100% family business
- 520 people over 13 subsidiaries in 3 continents

dehon group

climalife

Refrigeration, air conditioning and heating

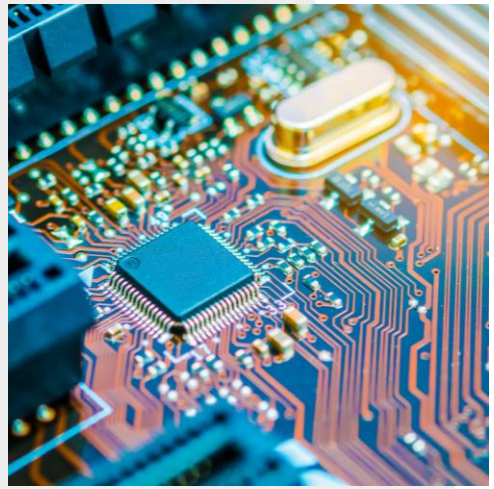
SMBAUTO

Car care solutions & services

SODEREC INTERNATIONAL

High-risk chemicals

INVENTEC PERFORMANCE CHEMICALS



Soldering, Cleaning & Coating

INVENTEC PERFORMANCE CHEMICALS

KEY FEATURES

60 years experience

More than **1 500** customers

More than **300** products

10% of turnover invested in R&D

SUSTAINABILITY & CIRCULARITY

GREENWAY™

Our sustainable development process

ECOPROGRAM

Service offered by Inventec for the collection and recycling of polluted fluorinated solvents

SAFETY

No CMR containing substances in the formulation of our products

SOLDERING

CLEANING

COATING

INVENTEC PERFORMANCE CHEMICALS

INVENTEC PERFORMANCE CHEMICALS

ADDED VALUE

A WORRYLESS ALL-IN-ONE SOLUTION

Inventec is unique in the market, providing a **COMPATIBILITY** between its Soldering, Cleaning & Coating solutions.

Our solder paste flux residues can be easily removed with our cleaners

SOLDERING

CLEANING

Most of our solder paste flux residues are compatible with our coatings and don't influence SIR or BONO reliability test outcome

Recommended to clean before coating to get optimal adhesion and to remove other unwanted contaminations on the PCB

COATING

OUR BRANDS

ECOREL™
ECOFREC ™
AMTECH ™

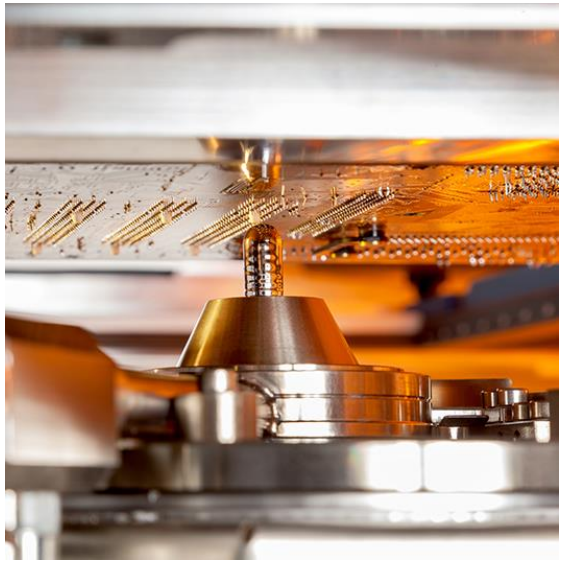
TOPKLEAN™
PROMOSOLV™
PROMOCLEAN™
QUICKSOLV™
3MTM NOVEC™
BLUEGOLD™
M-AERO™

PROMOSOLV™ COAT
ABCHIMIE™

INVENTEC PERFORMANCE CHEMICALS

SOLDERING PRODUCTS RANGE

OVERVIEW



- METAL & POWDERS
- SEMICON SOLDER SOLUTIONS
- SMT SOLDER PASTES
- SOLDERING & TINNING FLUXES
- REWORK & REPAIR SOLUTIONS

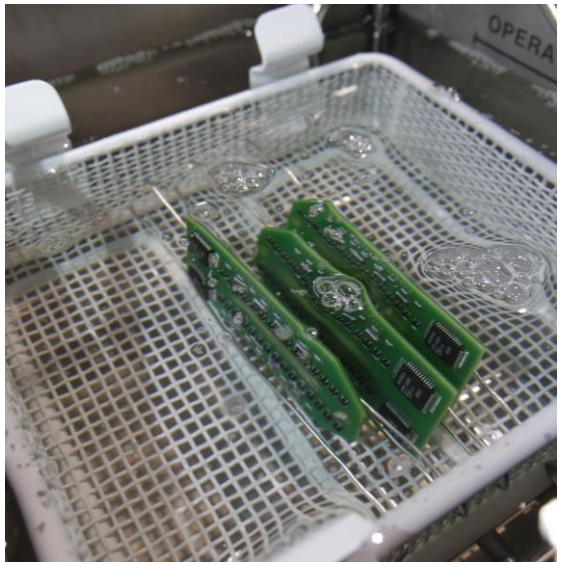
TOP PRODUCTS:

- ECOFREC™ 200
- ECOREL™ FREE 305-16LVD
- ECOREL™ HT 296

INVENTEC PERFORMANCE CHEMICALS

CLEANING PRODUCTS RANGE

OVERVIEW



- ADDITIVE MANUFACTURING
- DE-OXYDATION
- DEGREASING
- ELECTRONIC & SEMICON CLEANING
- OXYGEN PARTS CLEANING
- PARTICLES REMOVAL
- POLISHING PRODUCTS, POLYMERS & RESINS REMOVAL
- RINSING & DRYING SOLVENTS

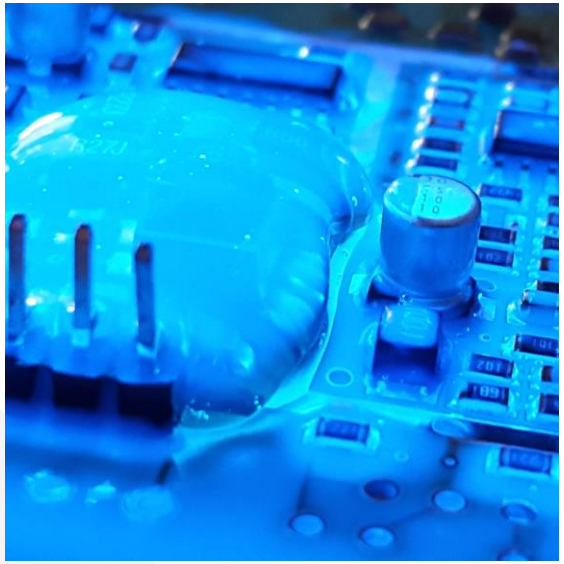
TOP PRODUCTS:

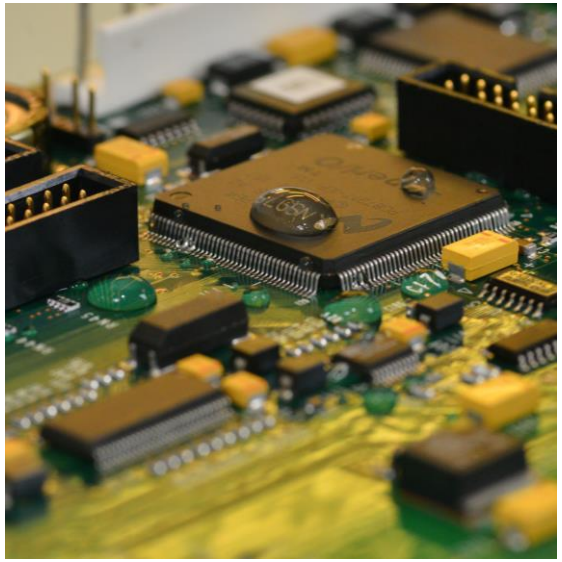
- TOPKLEAN™ EL 20A
- PROMOCLEAN™ TP 125
- TOPKLEAN™ EL 606

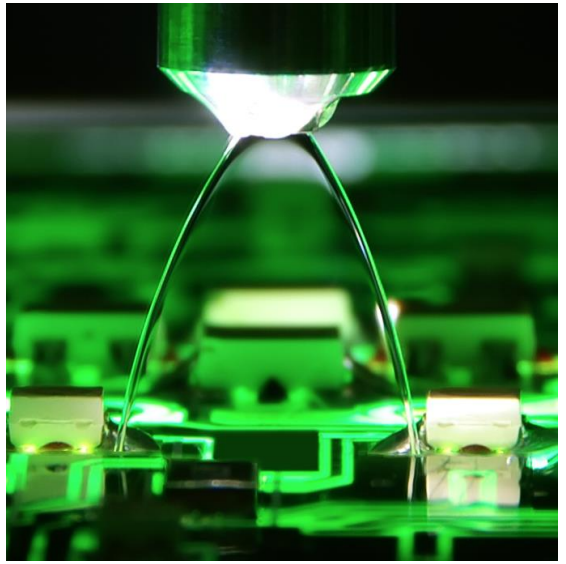
INVENTEC PERFORMANCE CHEMICALS

COATING PRODUCTS RANGE

OVERVIEW







- CONFORMAL COATINGS
- NANO (EPILAME) COATINGS
- ULTRA-THIN COATINGS

TOP PRODUCTS:

- ABCHIMIE™ AVR80 BA
- PROMOSOLV™ COAT UT10
- ABCHIMIE™ 746UV

INVENTEC PERFORMANCE CHEMICALS

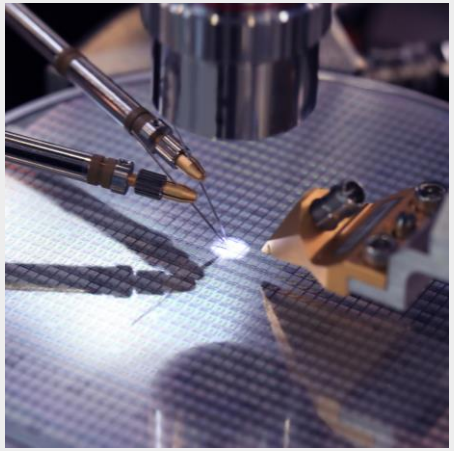
HIGH-TECH INDUSTRIES

« PRODUCTS MADE FOR HIGH RELIABILITY »

AEROSPACE

AUTOMOTIVE

SEMI-CONDUCTOR



ENERGY & AUTOMATION

MEDICAL

MICRO-MECHANIC

MEMBER OF

next move

acsiel Alliance Electronique

GIFAS

INVENTEC PERFORMANCE CHEMICALS

INVENTEC WORLDWIDE

- All production sites certified under ISO 9001
- France, China and Mexico certified under ISO 14001
- Technology transfer between sites
- Quality consistency among continents
  → Materials, methods, machinery, manpower, environment

3
R&D LABORATORIES

7
PRODUCTION SITES

9
SUBSIDIARIES

WORLDWIDE
DISTRIBUTOR NETWORKS

INVENTEC
PERFORMANCE CHEMICALS

OUR VALUES

PROXIMITY

A WORDLWIDE PRESENCE TO SUPPORT OUR CUSTOMERS

PROTECTION

SUSTAINABLE SOLUTIONS FOR USERS AND ENVIRONMENT

PERFORMANCE

SPECIALIZED TEAMS AND EFFECTIVE TECHNICAL SOLUTIONS TO SERVE OUR CUSTOMERS

INVENTEC PERFORMANCE CHEMICALS

Inventec Soldering Materials

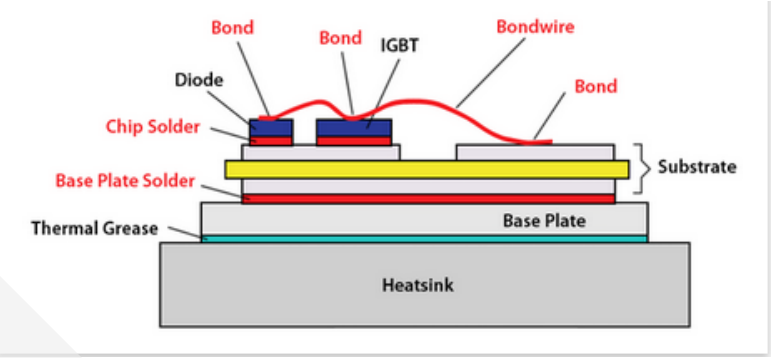
INTERCONNECTION FOR POWER ELECTRONICS

TECHNICAL CHALLENGES

To interconnect chip die attach, IGBT and Wide band Gap Sic and GaN power modules , Inverters , DC-DC chargers, there is a big demand for now and the future , and 2 way of approach:

- **High demanding power electronics mainly for the SEMICON Industry and some Automotive and spatial application Pb92.5Sn5Ag2.5 (T°F 290-298°C) et du Pb85Sn5Sb10 (T°F 239-243°C) :**

- **Less demanding power components than the previous described (Typically e-Vehicle, Automotive Subcon, Energy) IGBT or Mofset: Components for POWER ELECTRONICS but more demanding in operating temperature than what can be achieved with SAC 305**



OUR MATERIALS OFFER A HIGH SMT PRODUCTION YIELD

INVENTEC PERFORMANCE CHEMICALS

SOLDERING MATERIALS

TECHNICAL CHALLENGES

PRINTABILITY

- Rheology, Solder paste stability
- Ultra fine deposit repeatability in mass production with T5,T6,T7 powder particles
- Resistance of moisture absorption during printing

REFLOW

- Good wettability
- Ultra Low void level requested
- No splashing / fluxes projection / splattering

POST REFLOW

- Reliability of No clean residue (No corrosion, no ECM, No CAF)
- Good Cleanability of flux residue
- Minimize sensitive metals oxidation
- High mechanical strength and resistance to thermal cycling

OUR MATERIALS OFFER A HIGH SMT PRODUCTION YIELD

INVENTEC PERFORMANCE CHEMICALS

SOLDERING MATERIALS

ECOREL MAIN FEATURES

PCBA ASSEMBLY

- Chemical reliability of No Clean residues after reflow
- Very low solder voids on large area components:

  TO-220, DPaks, SMD, etc
- Compatibility with conformal coatings
- Robust assembly process
- Halogen free
- Alternative lead-free alloys

POWER MODULES / POWER DISCRETES

- High thermal cycling performance
- Excellent wetting on DCB / and different leadframe
- Minimal presence of solder voids including large die attachment
- Excellent performance under vacuum reflow. Very low splattering.
- Flux residues are very easily cleaned
- Halogen Free

DIE ATTACH SOLDERING MATERIALS

SOLDER PASTE

ECOREL HT 296& HT301

- Pb92.5Sn5Ag2.5 available in T3, T4, T5 on request
- MP 290-298°C
- Ideal for die attach soldering process
- Very good printing or dispensing behaviour, does not stick in the stencil or provide a repeatable dispensing process
- No Clean / Non-corrosive residue after reflow
- Low voiding performance
- Easy to be cleaned with solvent / hydrocarbon or detergent defluxing agent

ECOREL HT 240

- Pb85Sn5Sb10 available in T3, T4, T5 on request, also available PbSn5 version
- MP 240-243°C
- Ideal for die attach soldering process
- Very good printing or dispensing behavior, does not stick in the stencil or provide a repeatable dispensing process
- No Clean / Non-corrosive residue after reflow
- Low voiding performance
- Easy to be cleaned with solvent / hydrocarbon or detergent defluxing agent

ECOREL FREE 300-31A

- Sn96,5Ag3,5 designed for Power Module / IGBT assembly on DCB or IMS substrate
- MP 210°C
- Applicable for vacuum soldering in conduction or vapour phase oven.
- Transparent and colorless residue + minimize the Cu oxidation / discoloration
- Very low voiding performance on Cu
- Wide range of application = dispensing, printing applications
- No Clean / Non-corrosive residue after reflow but very easy to clean with solvent, hydrocarbon or detergent base process

INVENTEC PERFORMANCE CHEMICALS

SOLDERING MATERIALS

NO CLEAN SMT OR DIE ASSEMBLY

ECOREL™ FREE 305-16 LVD

- Ideal for heterogenous packaging assembly as System in Package
- Reliable flux systems available with different alloys composition such as SAC, SnAg, HTO150, SnSb...
- High-definition printing performances
- Ultra low voids percentage and reduction of voids size in large contact area components
- Very good wetting on any substrate surface finish such as OSP
- Excellent cleanability of residues with the different aqueous or solvents solutions
- Available in type 3 to type 6 / type 7 on request

INVENTEC PERFORMANCE CHEMICALS

SOLDERING MATERIALS

NO CLEAN SMT OR DIE ASSEMBLY

ECOREL™ HTO 150-16LVD

- Inventec alloy improvement: SACBi + Dopants
- SAC 305, SAC405, SnAg, have limited performances for High Operating Temperature and Thermal Shock (several conditions depending on final use, board and components)
- New alloy with higher reliability for complex assembly of different characteristics materials (CTE, Tg, Young Modulus)
- Inventec solution SACBi + other elements (No antimony): HTO alloy
- High-definition printing performances
- Ultra low voids percentage and reduction of voids size in large contact area components
- Very good wetting on any substrate surface finish such as OSP
- Excellent cleanability of residues with the different aqueous or solvents solutions
- Available in type 3 to type 6 / type 7 on request

INVENTEC
PERFORMANCE CHEMICALS

SOLDERING MATERIALS

WATER WASHABLE SMT OR DIE ASSEMBLY

ECOREL™ FREE 305-WS12 – 400-WS12

- Ideal for advanced packaging assembly as System in Package
- Repeatable printing performance
- High resistance of moisture absorption during operation
- Good wettability and very low voiding
- Superior fine pitch soldering ability
- Residues after reflow easily removed either by pure DI water or by DI water + a detergent
- Type 4 to type 6 / type 7 on request
- Available in different alloys: SnAg4, SAC305, SnAg3,5…

INVENTEC PERFORMANCE CHEMICALS

CHALLENGES FOR SOLDERING LARGE CHIPS ONTO COPPER DBC SUBSTRATES

GOAL

Achieve consistent, robust and reliable bond-line thicknesses (BLT) between large dies, chips and diodes onto the DCB copper substrates.

REQUIRED SOLDER PASTE PROPERTIES

In order to allow such consistent and reliable connections, an optimized solder paste must fulfill the following requirements:

- **Easy residue cleaning**
- **No copper discoloration/oxidation**
- **Low and repeatable voiding level**
- Minimized flux spattering and solder leaking
- Good and consistent wettability on Cu
- High printing consistency on large areas

DISCOLORATION / OXYDATION OF COPPER

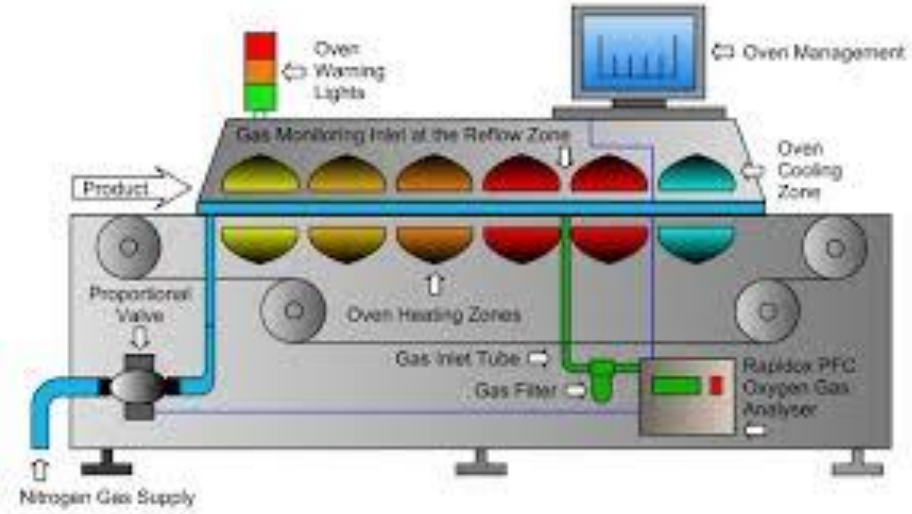
Copper discoloration/oxidation may be due to:

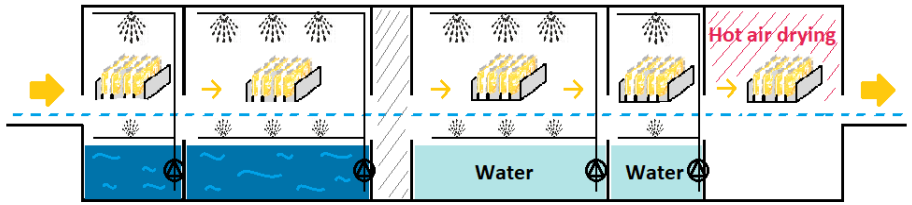
- **Soldering process (main root cause)**
- **Cleaning process**

Copper discoloration/oxidation means a change of the copper surface properties

→ Poor Wire-bonding step

Then, Copper oxidation must be prevented





IN-LINE SPRAYING MACHINE

INVENTEC PERFORMANCE CHEMICALS

DISCOLORATION / OXYDATION OF COPPER

INFLUENCE OF SOLDER PASTE FLUX FORMULATIONS

DESCRIPTION OF THE EXPERIMENT:

1. Solder pastes:

- Alloy SnAg3,5 type 3 89%
- ROL0 (no halide) and halogen-free
- Change in flux formulation only

2. Printing and placement:

- 2x square stencil apertures 250 microns thick
- with and without die

3. Soldering process:

- Standard, about 30min duration, nitrogen, with vacuum steps (customer proprietary)

4. Cleaning process:

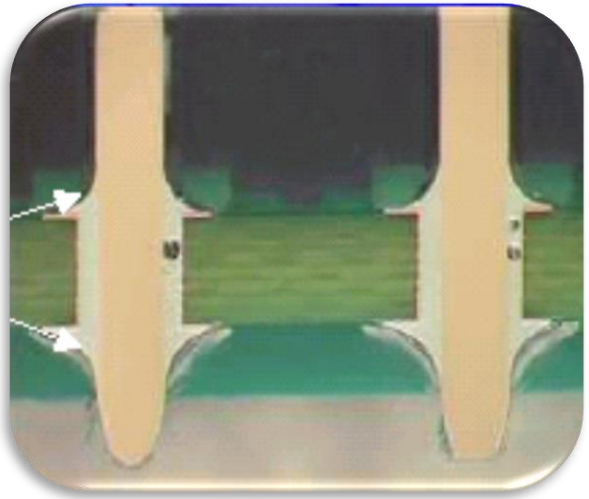
- Co-solvent (hydrofluoroether / hydrocarbon)
- 24hours after soldering step

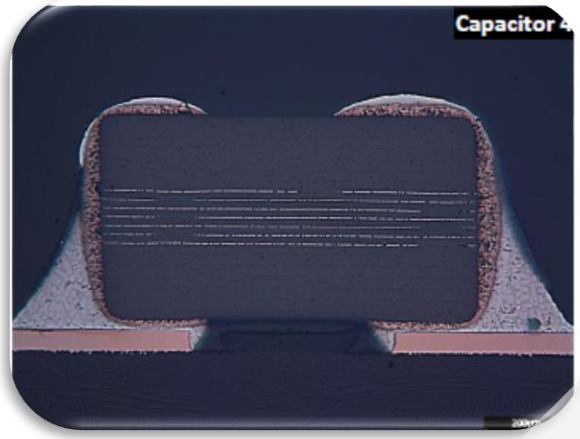
VOID DESCRIPTION

- Cavities in solder joints
- From outgassing flux during reflow

  → entrapped after alloy solidification

  - Solvent evaporation
  - Thermal decomposition of flux ingredients
  - Deoxidation reaction between flux and metallizations

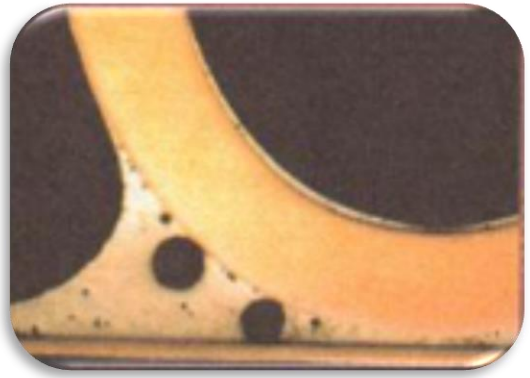


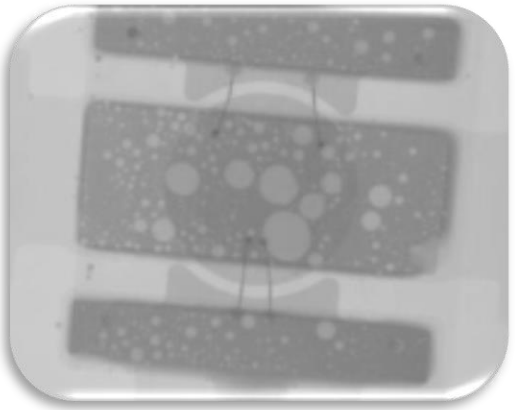


VOID CONSEQUENCES

- Electrical conductivity
- Thermal dissipation performance
- Mechanical reliability
- Product working life

	Thermal conductivity (W/m.K)
SAC305	60
Air	0,025





SUMMARY OF INFLUENT INGREDIENTS

- **RESINS** → **Minor influence**
- **ACTIVATORS** → **Major Influence**
- **SOLVENTS** → **Major Influence**
- **ADDITIVES** → **Influence depends on additive**

- ✔ Use of solvent with high boiling point preferred
- ✔ Synergy between high and low boiling point solvents gives the best results in term of voids
- ✔ In addition, this combination enhances the paste workability
- ✔ Solvent's choice and combination is a key parameter

HOW TO DECREASE THE VOID IN SOLDER PASTES

DECREASE ALLOY SURFACE TENSION

Increase deoxidizing properties (flux activation)

→ Increase acid quantity / amine quantity / short chain acids quantity / use halides or halogen compounds, …

MINIMIZE OUTGASSING DURING REFLOW STEP

Use solvents with boiling points out of the alloy melting point and thermal profile peak temperature

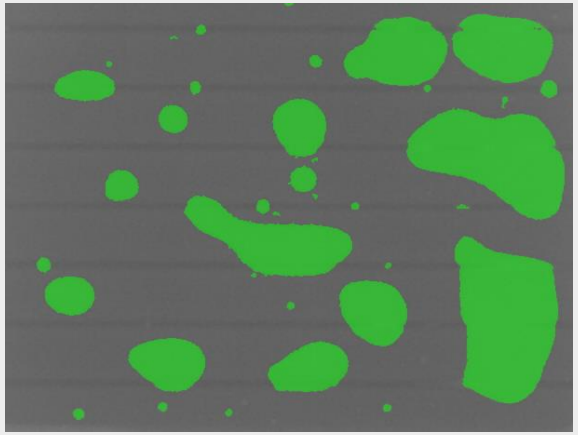
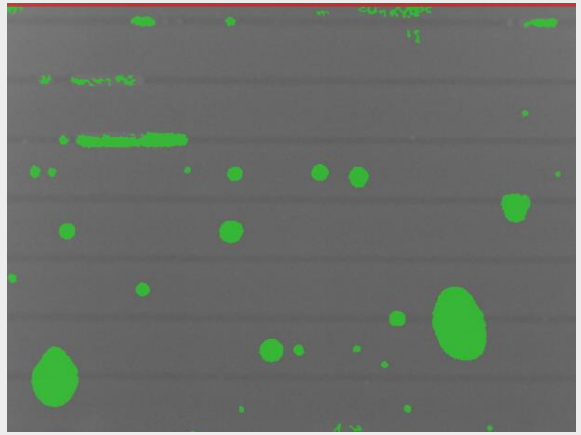
→ Limit solvents quantity with boiling temperature around 215-240°C

OTHER PASTES PROPERTIES MUST BE UNCHANGED

- Reflow performance
- Printability
- Stencil life
- Chemical reliability

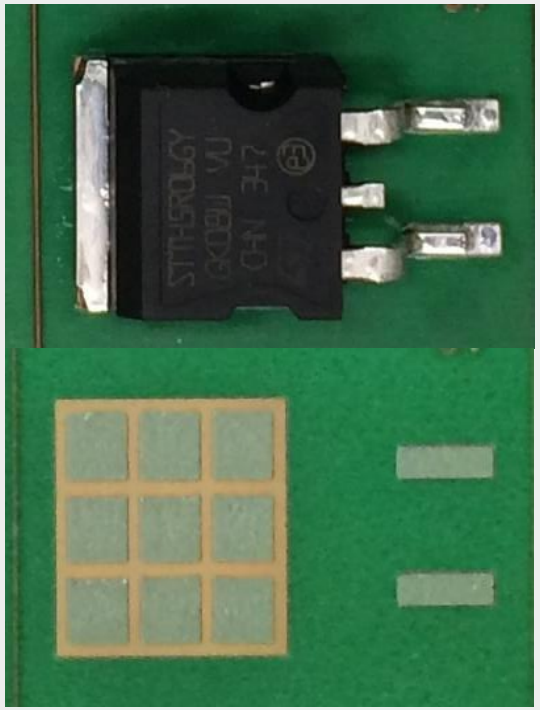
DECREASING THE VOID FOR A CHIP BY CHANGING THE FORMULATION

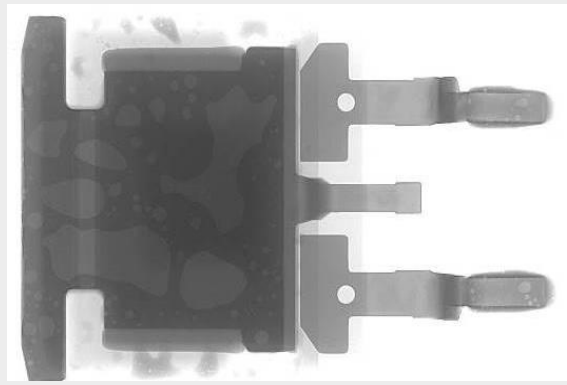
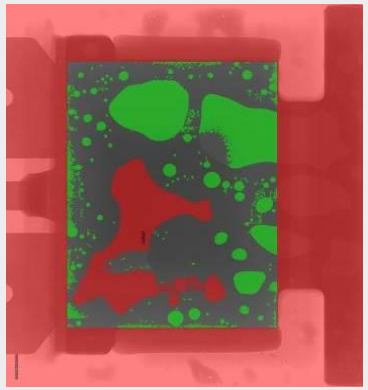
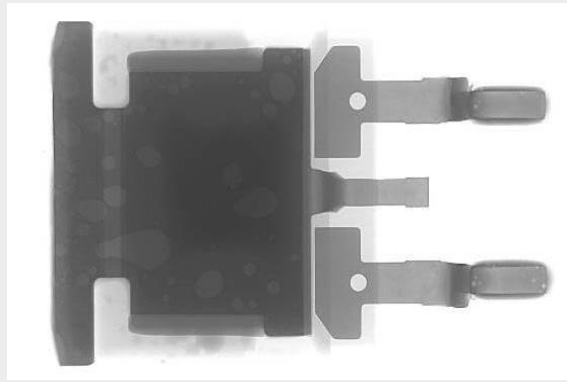
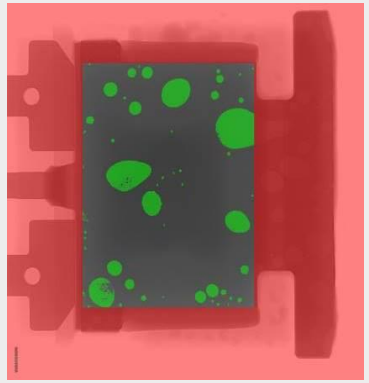
EXAMPLE: OPTIMIZATION OF THE FORMULA TO IMPROVE THE VOIDS ON A CHIP

FORMULATION	Typical	Optimized
		
VOID %	27%	4,5%

OTHER EXAMPLE : DECREASING THE VOID ON OTHER COMPONENTS

OPTIMIZATION OF THE FORMULA TO IMPROVE THE VOIDS ON A D2PAK



Typical Paste Reference 39.28%		
LVD Solder Paste 13.40%		

INVENTEC PERFORMANCE CHEMICALS

Inventec Cleaning Solutions

CLEANING MATERIALS

TECHNICAL CHALLENGES

PERFORMANCE

- Very Low stand off capacity
- Using of last generation substances
- Wide flux residues compatibility
- High efficiency of particles and flux removal especially for RF system
- Repeatable process to ensure high molding compatibility performance

PROCESS FOLLOW UP

- Automatic in line analysis system
- All equipment compatibility
- Local engineering support

REGULATIONS

- REACH / ROHS / FGAS and other local legislation
- Be closed and ahead of next regulation / legislation

CLEANING MATERIALS

PRODUCTS ACCORDING TO LEGISLATION

WATERBASED SOLUTIONS

- REACH
- Disposal & water treatment
- Water consumption

Used molecules:
Amines,
glycol ether,
surfactants,
etc.

FLUORINATED SOLVENTS

- **Solvent regulations Fgas, REACH**
- **VOC emissions**
- Solvent waste treatment

Used molecules:
HCFCs
nPB
HFC
HFE
Brominated solvent,
chlorinated solvents

OXYGENATED / HC SOLVENTS

- REACH
- VOC emissions
- Solvent waste treatment

Used molecules:
Modified alcohols,
hydrocarbons,
etc.

CLEANING PARAMETERS

TO BE CONSIDER

- Mechanical action in cleaning and rinsing (spray nozzle design and layout for example)
- Compatibility with cleaner
- Production rate

Machine design

Cleaner

Process follow up

Pollutant

- Good wettability
- Low environmental impact
- Good solubilisation of the fluxes
- Reducing foam brought by pollutants

- Process optimization
- Bath follow up
- Evaluation of the bath life

- Type of contaminants to remove vs attack of some components
- Compatible with the cleaner and the process

INVENTEC PERFORMANCE CHEMICALS

Inventec Aqueous Cleaners

INVENTEC
PERFORMANCE CHEMICALS

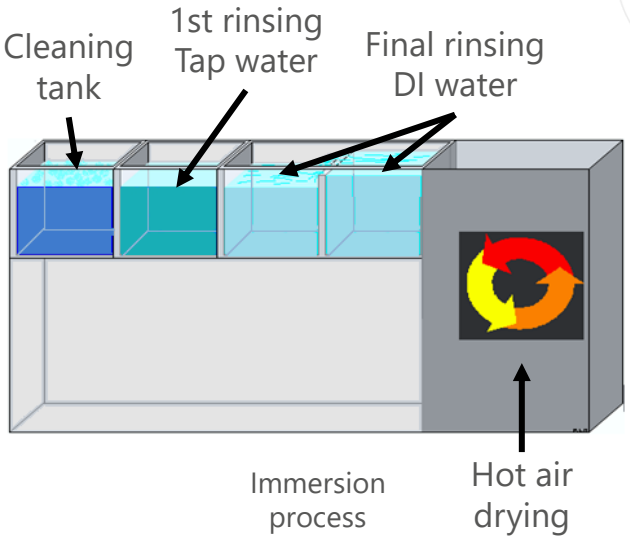
PROMOCLEAN RANGE

IMMERSION PROCESS DEDICATED

PROMOCLEAN

TP 1128

- **Type:** Alkaline product
- **Application:** Stainless parts and maintenance cleaning
- **Use:** For dipping machine, recommended used from 10 to 30%



PROMOCLEAN

TP 60

- **Type:** Alkaline product
- **Application:** PCBA cleaning
- **Use:** For dipping machine, recommended used at 30%
- **Compatibility:** Compatible with all plastics

PROMOCLEAN

Disper 707

- **Type:** Alkaline product
- **Application:** Glue removal, PCBA cleaning
- **Use:** Batch immersion, in line immersion machine, have to be uses with immersed jets
- **HSE:** Non-toxic, non-flammable, *DG classified for transport in China*

PROMOCLEAN DISPER 707

ADVANTAGE AND CONDITION OF USE

MAIN ADVANTAGES:

- Can clean most of our Soldering products range
- No foam
- Not DG
- Compatible with copper, aluminum, stainless steel etc.
- Compatible with standard plastics and elastomers used in electronic applications
- Compatible with the cleaning machine
- Halogenated compound free

MACHINE: Batch spraying machine or Immersion with immersed jets

CONCENTRATION: 15% – 25% (recommended 20%)

TEMPERATURE: 50°C – 60°C

PROCESS FOLLOW-UP: with a handle refractometer

INVENTEC PERFORMANCE CHEMICALS

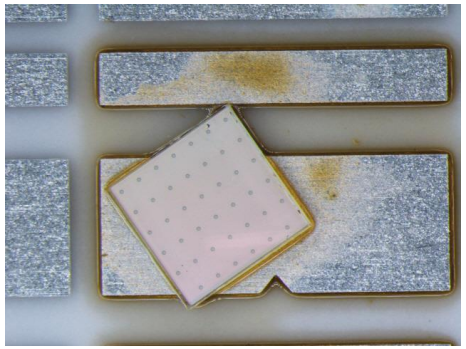
INVENTEC INTERNAL TRIAL

DISPER 707 cleaning compatibility with TF48

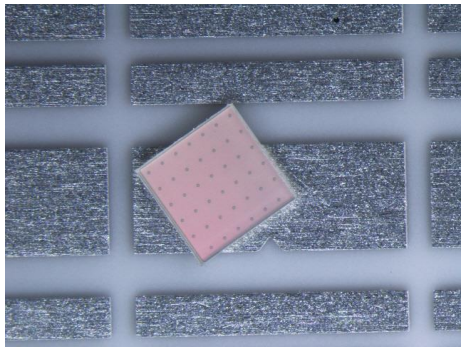
Cleaning tests have been done at INVENTEC site with PROMOCLEAN DISPER 707 and TF48 with remaining pieces from the qualification trials from last year.

PARAMETERS AND PROCESS:

- TF48 silk-screened with a stencil on customer substrate
- LED put on the substrate
- Heating 2min at 160°C and 30s at 300°C
- Cleaned in a spraying machine with DISPER 707 at 30% at 55°C



Before cleaning



After cleaning

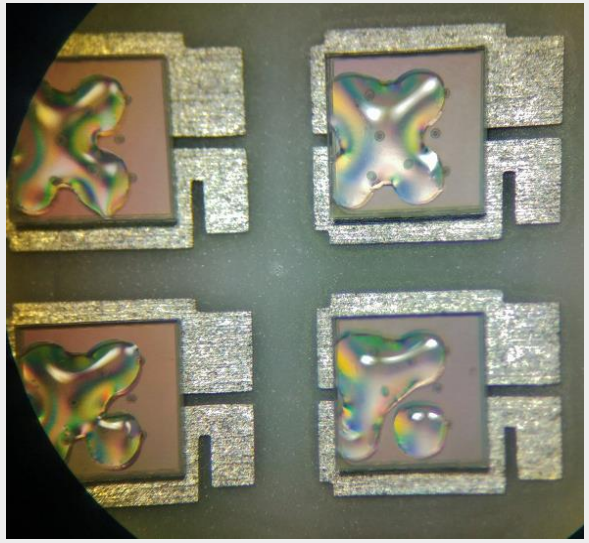
- **Very good cleaning performance**
- **Disper 707 is compatible with TF48**

INVENTEC PERFORMANCE CHEMICALS

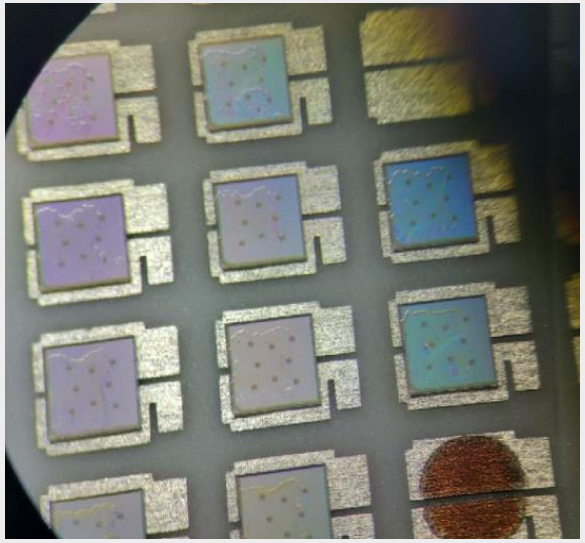
TRIAL AT CUSTOMER SITE

CLEANING TESTS

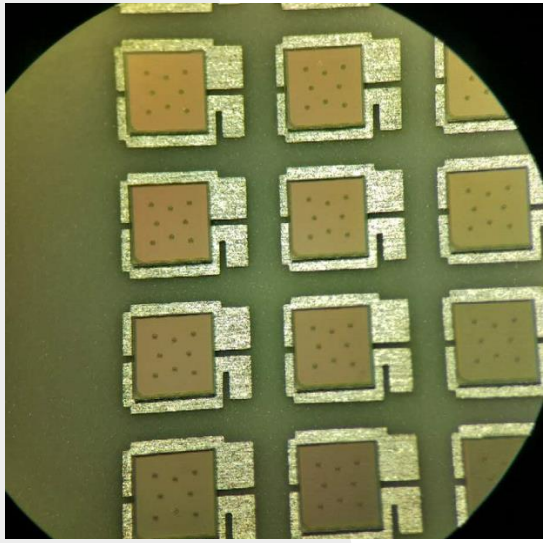
Cleaning tests have been done at customer site



After dipping flux



After reflow



After cleaning

No residues left after cleaning. This test confirms Inventec results.

✔ **Disper 707 is compatible with soldering materials**

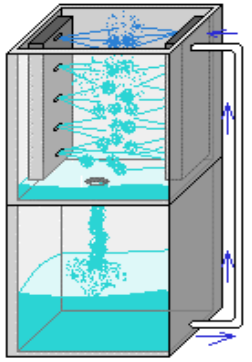
PROMOCLEAN DISPER RANGE

ASPERSION PROCESS DEDICATED

PROMOCLEAN

Disper 605

- **Application:** Glue removal, PCBA cleaning
- **Use:** Batch spray in air machine, spray in line machine, possible to use in dipping machines with immersed jets
- **HSE:** Non-toxic, non-flammable, *DG classified for transport in China*

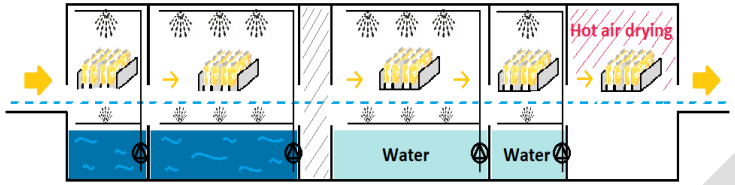


Batch spraying machine

PROMOCLEAN

Disper 607

- **Application:** High wetting performances to remove lead free soldering pastes and fluxes
- **Use:** For batch spray in air machine, possible to use in Spray in line machine and immersion machines with immersed jets
- **HSE:** Non-toxic, non-flammable, not *DG classified for transport in China*



Schematic of a In line spray machine

PROMOCLEAN

Disper 800

- **Application: High wetting performances to remove lead free soldering pastes and fluxes**
- **Use: For spray in line machine, possible to use in batch spray machine and immersion machines with immersed jets**
- **HSE: Non-toxic, non-flammable, not *DG classified for transport in China***

INVENTEC PERFORMANCE CHEMICALS

PROMOCLEAN DISPER 808

ADVANTAGE AND CONDITION OF USE

MAIN ADVANTAGES:

- **Higher cleaning efficiency** than our existing detergents
- Can clean most of our Soldering products range
- No foam
- Not DG
- Compatible with copper, aluminum, stainless steel etc.
- Compatible with standard plastics and elastomers used in electronic applications (To be confirmed for specific case)
- Compatible with the cleaning machine
- Halogenated compound free

MACHINE: in-line spraying machine (can be used also in off-line spraying machine)

CONCENTRATION: 15% – 20% (recommended 15%)

TEMPERATURE: 50°C – 60°C

INVENTEC PERFORMANCE CHEMICALS

Inventec Solvent Based Solutions

INVENTEC
PERFORMANCE CHEMICALS

CLEANING TECHNOLOGY

SOLVENTS

UNDERSTANDING SOLUBILITY & POLARITY…

- **Typical Pollutants:** Burnt mineral and organic compounds
- **Hydrophylic action:** Solubilization of polar and minerals compounds: metal oxides, partially burnt oxygenated compounds like polymers…
- **Lipophylic action:** Solubilization of non-polar: ex Resins, activators, organic acids, surfactants and high boiling point solvents
- Due to their chemical structures:
  - **Topklean EL 20A (hydrocarbon) is lipophylic**
  - **Topklean EL 20P (oxigenated solvent) is lipophylic & hydrophylic**

TOPKLEAN EL 20P

FEATURES

An excellent solvent cleaner to remove LEAD FREE flux residues

DEVELOPED TO

- Increase the wetting performance (lower the surface tension) to allow cleaning under low stand of components and tight spaces.
- Increase de-fluxing power for a wider range of No-Clean flux medium
- lower the HSE impact
- Increase Penetration Coefficient (from 27 to 35)

ADVANTAGES

- Excellent wetting performance
- Better rinsing capabilities vs waterbased cleaning
- Fast cleaning process (15 min total process)
- Recyclable HFE
- Dielectric chemistry can safely clean pre-charged parts (i.e. complex systems, power modules, batteries, etc)
- Great material compatibility

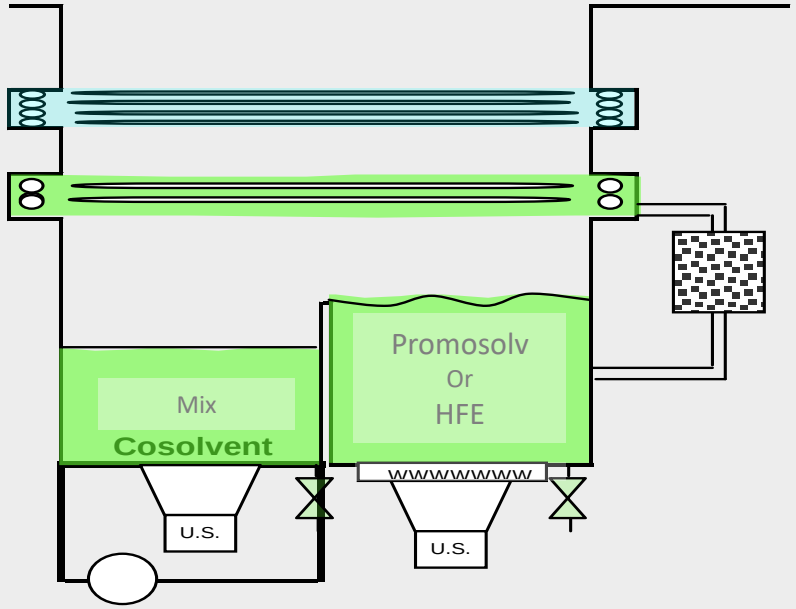
INVENTEC
PERFORMANCE CHEMICALS

TOPKLEAN EL 20P

SOLVENT PROCESSES

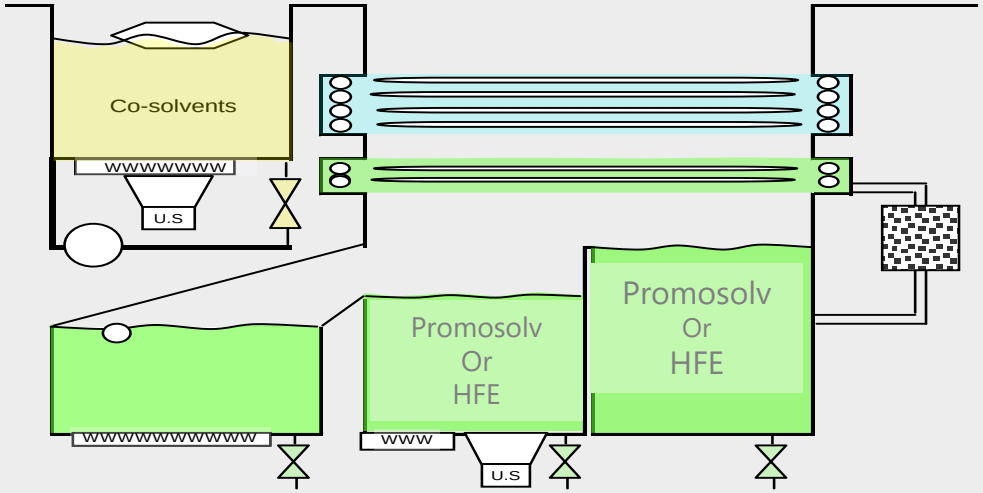
2 different vapor phase de-fluxing configurations possible

MIXED CO-SOLVENT



Topklean EL 20P **MIXED** with HFE for Cleaning step

SEPARATED CO-SOLVENT



Topklean EL 20P **PURE** for cleaning step

INVENTEC PERFORMANCE CHEMICALS

CO SOLVENT CLEANING

PROCESS

MIXED CO-SOLVENT

CLEANING

- **Temperature:** 60° C
- **Concentration:** 70 % Topklean EL 20P – 30 % HFE
- **Time:** 5 minutes
- **Mechanical action:** US if allowed

RINSING

- **Temperature:** 50° C
- **Time:** 5 minutes
- **Mechanical action:** US if allowed

DRYING

- **Temperature:** 55° C in vapor phase
- **Time:** 3 minutes

SEPARATED CO-SOLVENT

CLEANING

- **Temperature:** 45° C
- **Concentration:** 100 % Topklean EL 20P
- **Time:** 5 minutes
- **Mechanical action:** US if allowed

RINSING

- **Temperature:** 50° C
- **Time:** 5 minutes
- **Mechanical action:** US if allowed

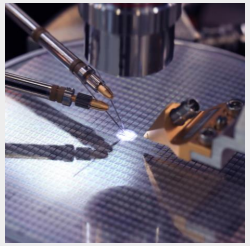
DRYING

- **Temperature:** 55° C in vapor phase
- **Time:** 3 minutes

INVENTEC PERFORMANCE CHEMICALS

HIGH-TECH SOLUTIONS

« PRODUCTS MADE FOR HIGH RELIABILITY »



C O N C L U S I O N

- **STRONG BACKGROUND IN CHEMISTRY AND FORMULATION OF CLEANING AND SOLDERING PROCESS**
- **INTEGRATION OF THE KNOW HOW IN METALLURGY**
- **ONE-STOP SOLUTION PROVIDER FOR AN ASSEMBLY PROCESS**
- **AHEAD OF THE EU LEGISLATION / REGULATION**
- **GLOBAL SUPPORT AND SUPPLY CHAIN**

INVENTEC PERFORMANCE CHEMICALS

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INSPIRING INNOVATION

THANK YOU

FOR YOUR ATTENTION

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