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Webinar:
Achieving Excellence in RAIN RFID IC Attach Process

February 8, 2024

Expert Introductions

Hannes Jehle

Product Manager

DELO

James Guzzo

Senior Vice President of
Silicon Engineering

IMPINJ

Juho Partanen

VP of Industrial Partnerships
Voyantic

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Talking Points

1. Smart label manufacturing process
2. IC attach process
3. Challenge: numerous process variables
4. Solution: manufacturing recipes
5. Manufacturing process monitoring
6. Q&A

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01

Smart Label Manufacturing Process

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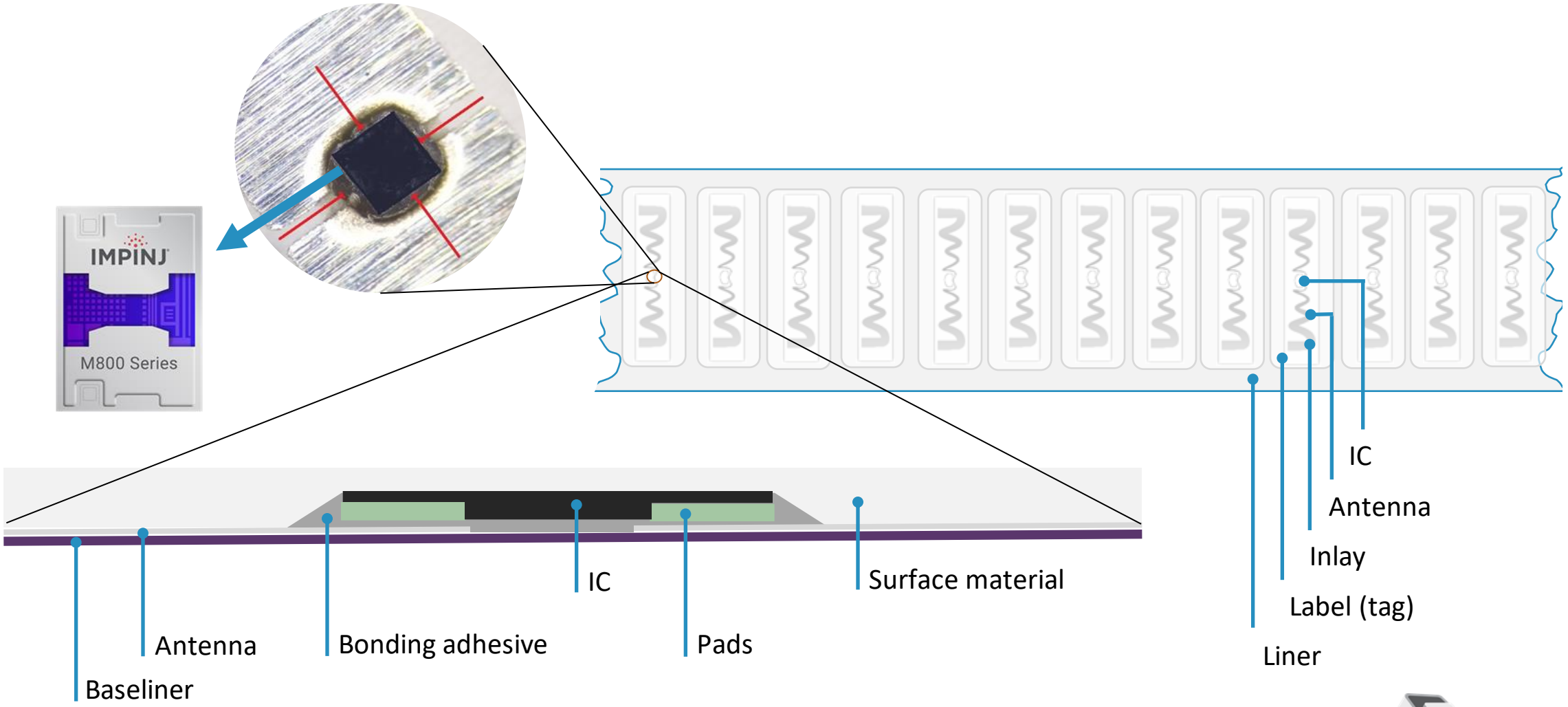
RAIN Label Structure



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RAIN Label Manufacturing Process

CHIP ATTACH

Chip (IC) is connected to an antenna

LABEL CONVERTING

Inlays are separated and material layers are added

PERSONALIZATION

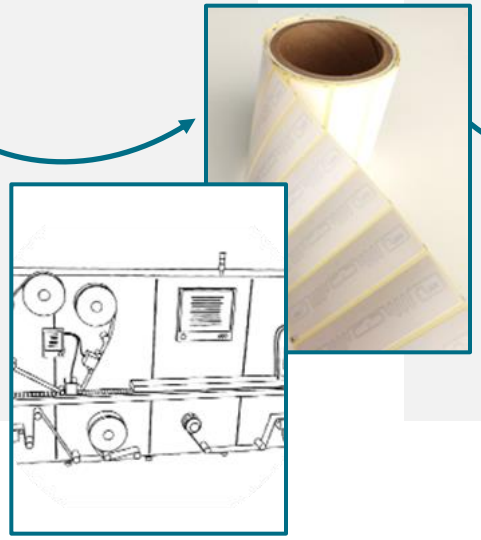
Label is programmed and printed

ATTACHMENT

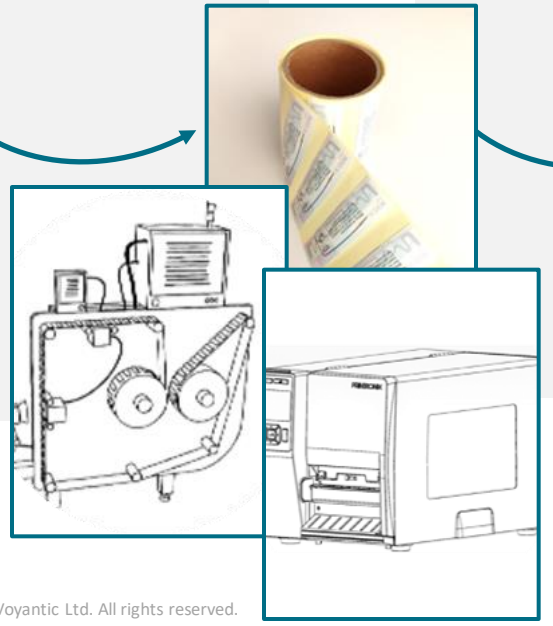
Label is applied on or attached to the item

INLAY

BLANK LABEL



FINISHED LABEL



TAGGED ITEM

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02

Dry Inlay Assembly - IC Attach Process

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Primary Inputs to the Dry Inlay Assembly Process

- Roll of blank Inlays - Aluminum antennas on a PET substrate
- ACP (Anisotropic Conductive Paste) or epoxy with metal fragments
- Chips /Die / ICs - A Diced Wafer on Tape in Frame

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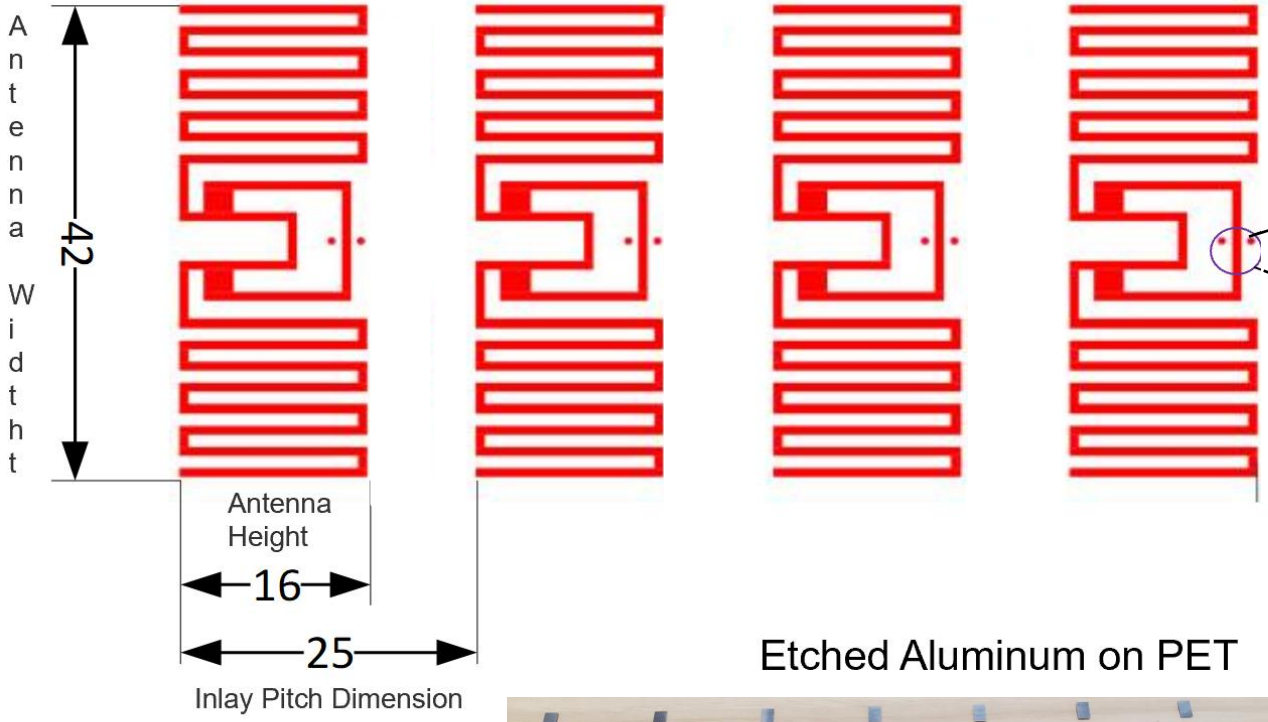
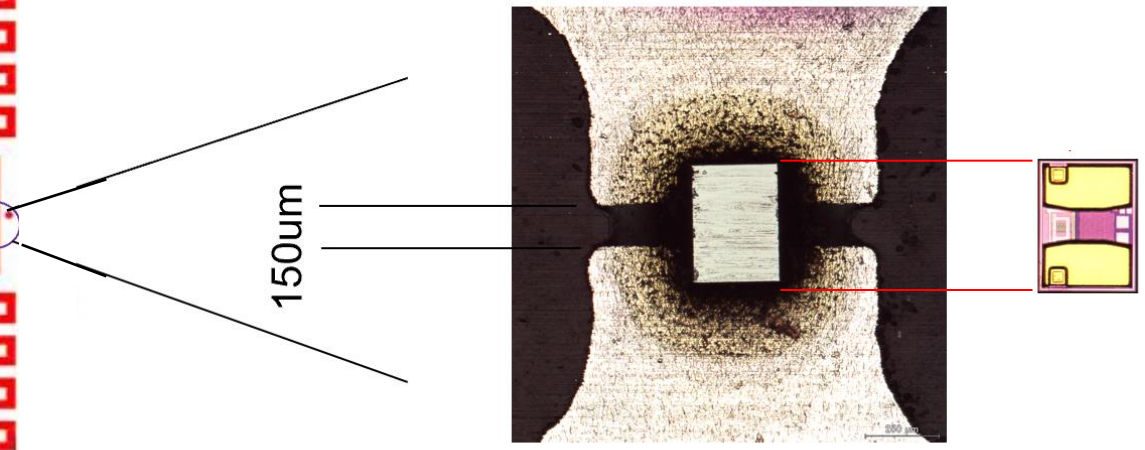
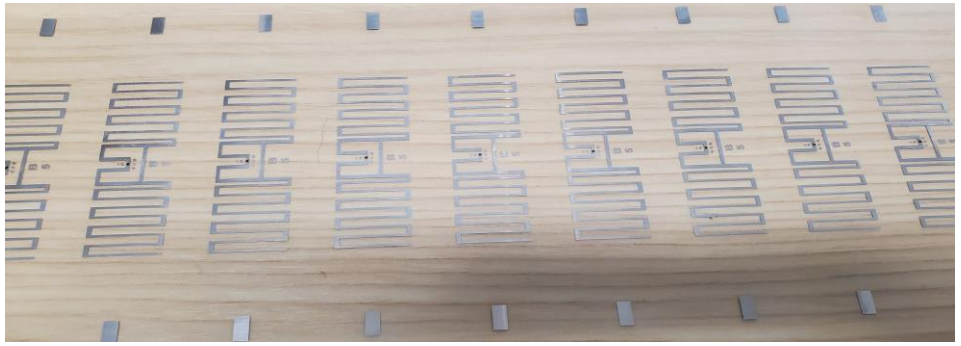
Etched Aluminum Antennas on PET Substrate

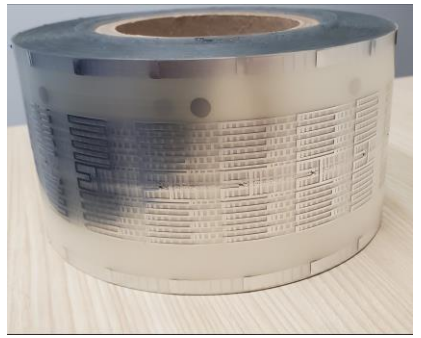




Chip attached with ACP across gap

Etched Aluminum on PET





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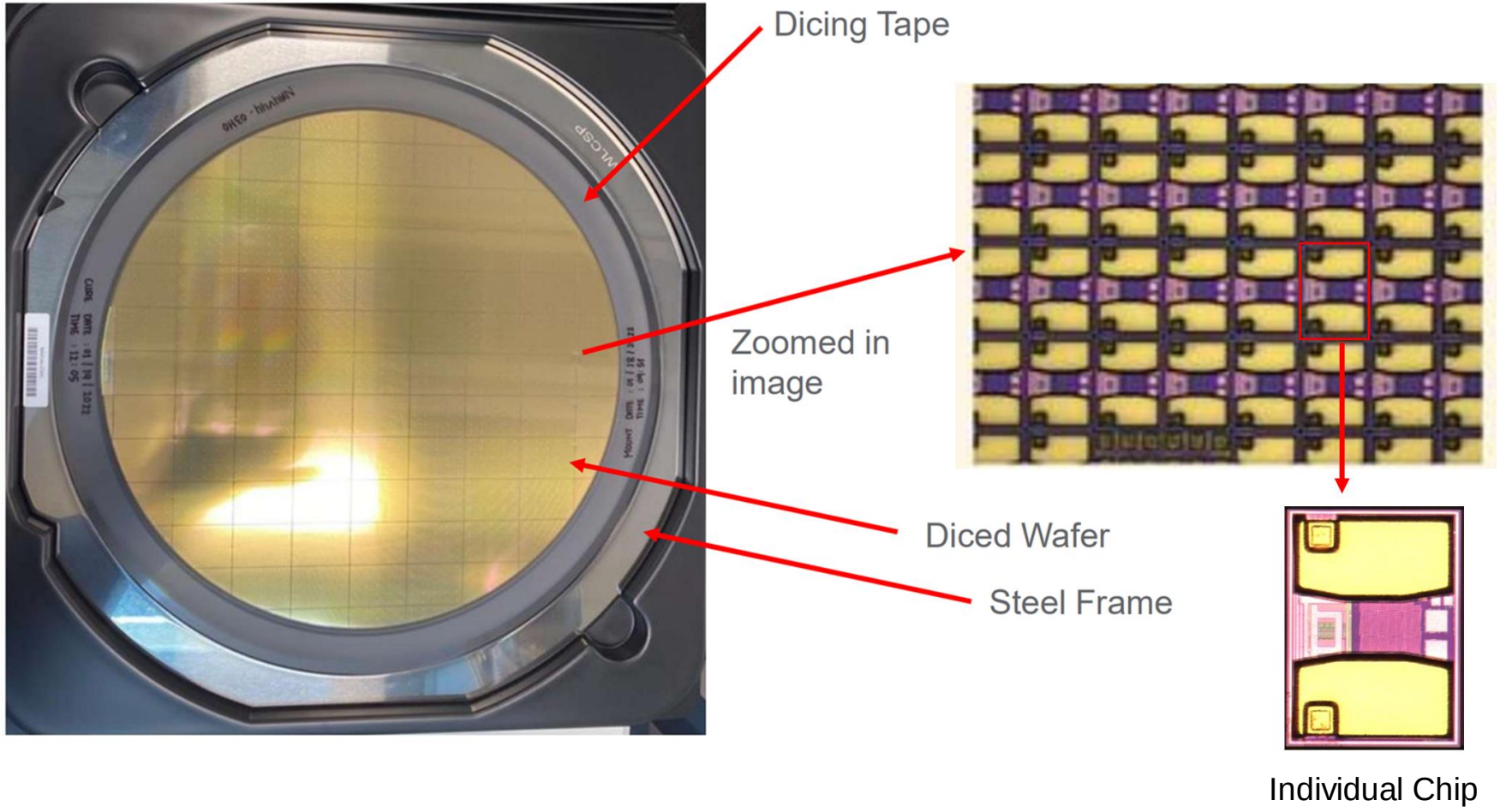
Diced Wafer on Tape in Frame



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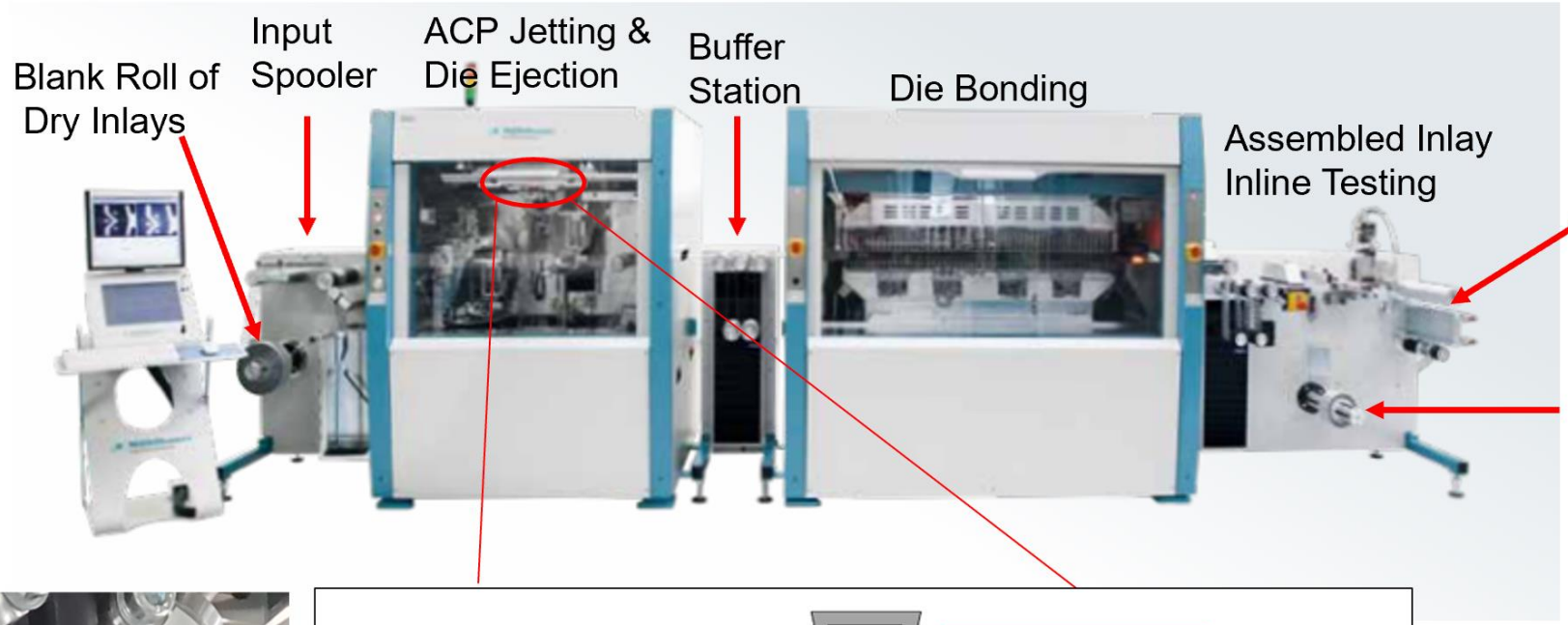
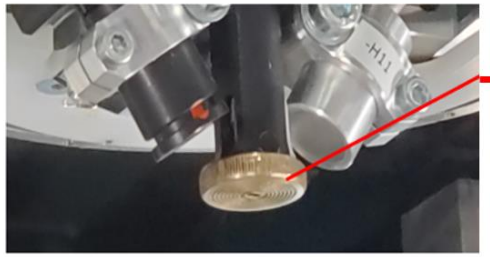
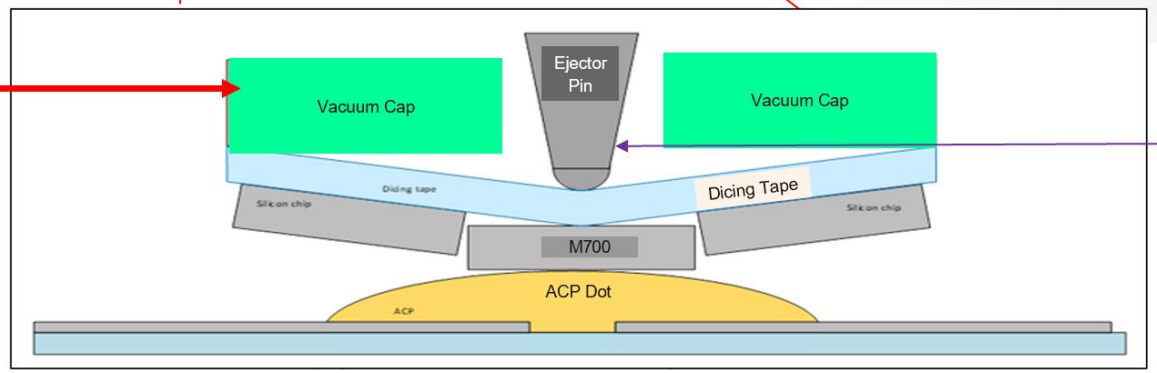
DDA – Direct Die Attach Machine







Ejector Needle centered on target die pushes the die off the dicing tape into the ACP(glue)

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03

Challenge: Numerous Process Variables

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FAMILY-OWNED

€ 230 M.
REVENUES

1050
EMPLOYEES

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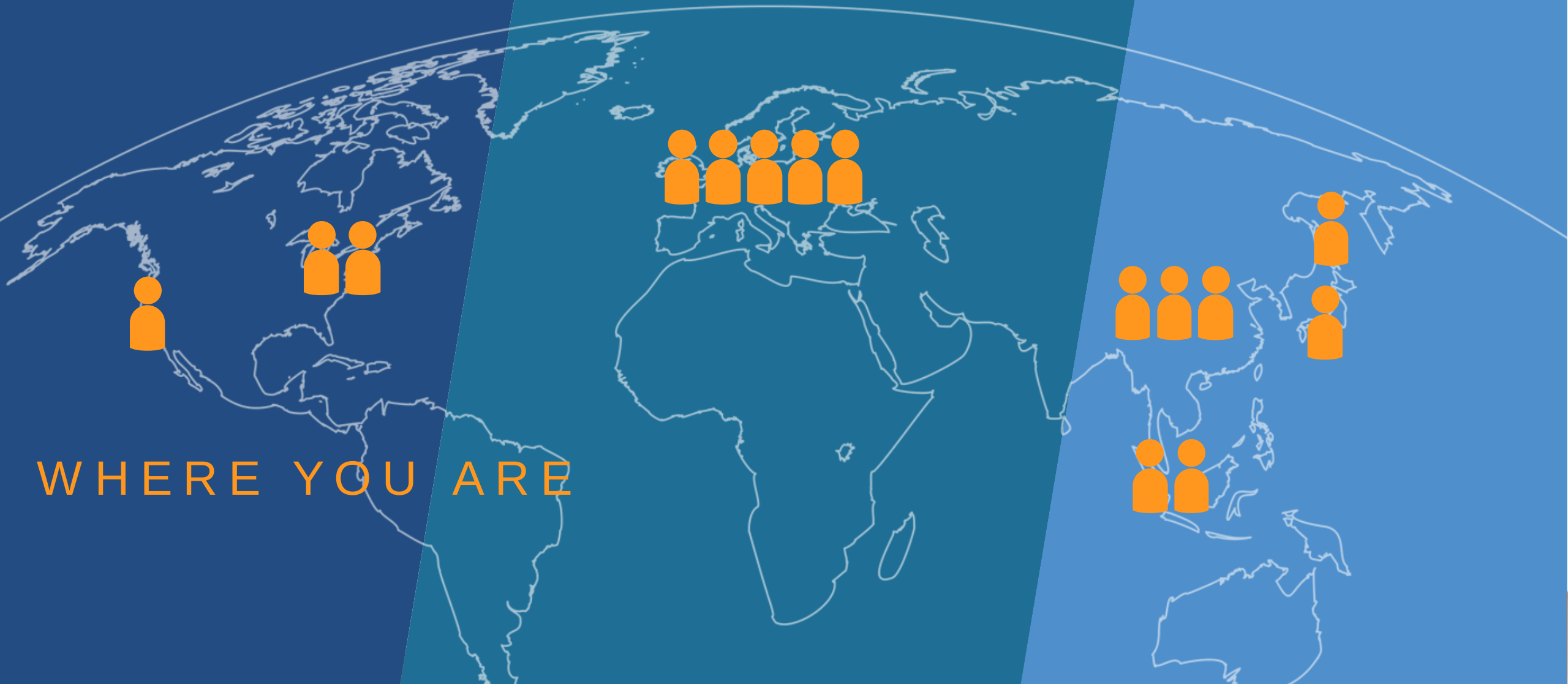
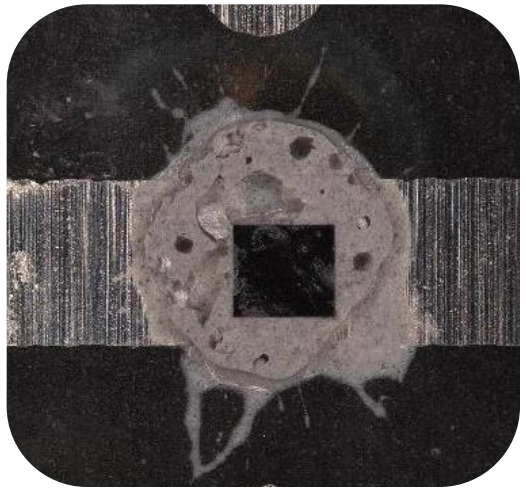
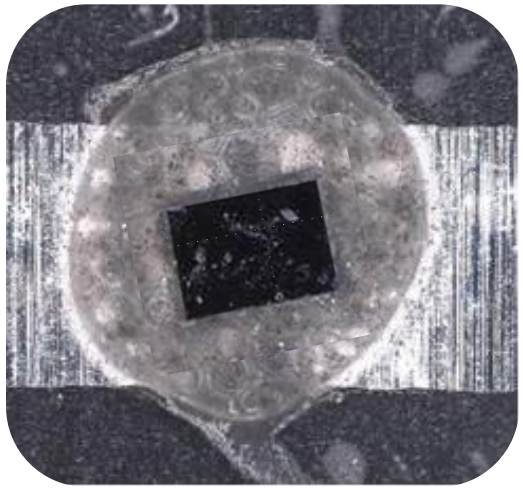
WE ARE

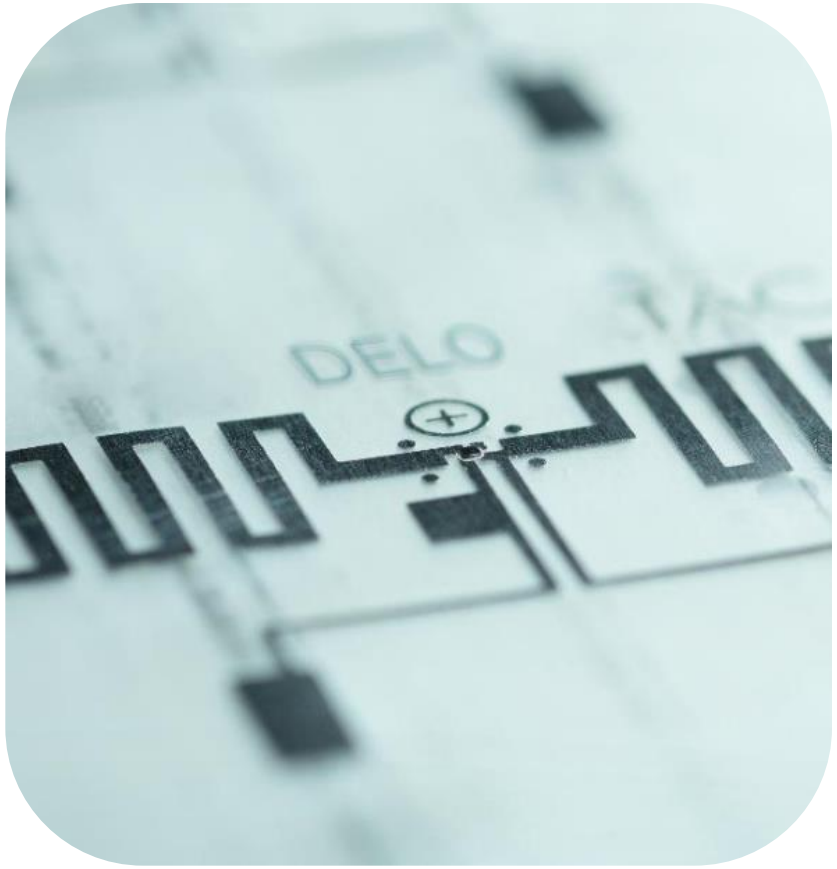


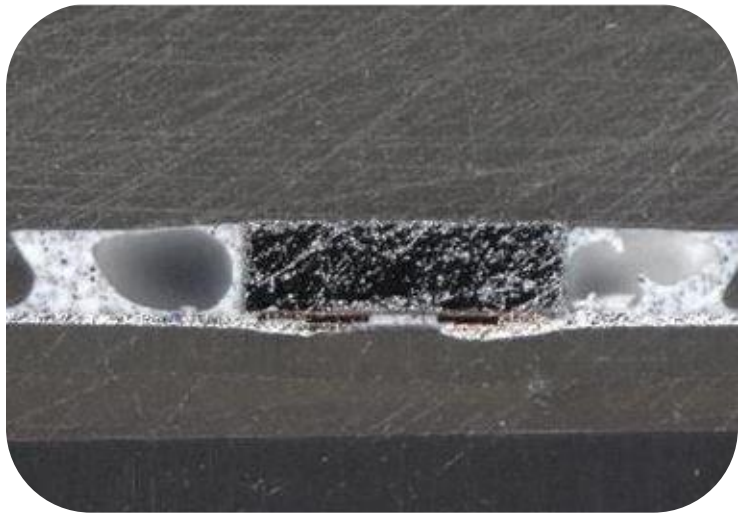
WHERE YOU ARE

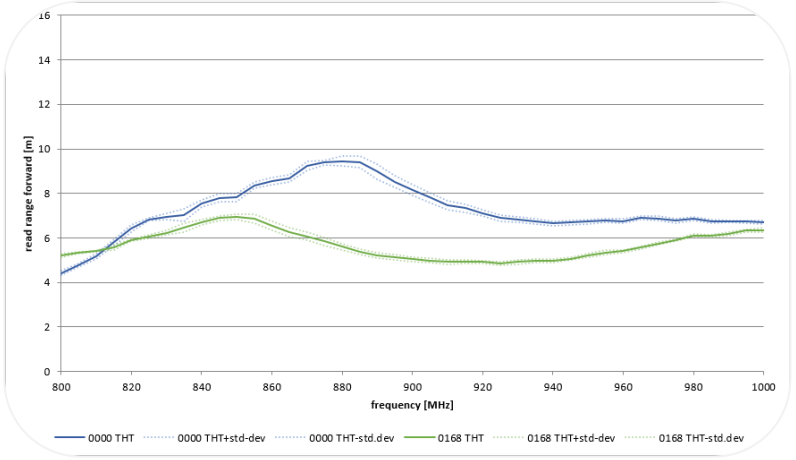
Good Bonding is Essential for Perfect Label Quality











Results like this lead to a bad label quality!

Influence Factors of Adhesives to the Quality of Inlays

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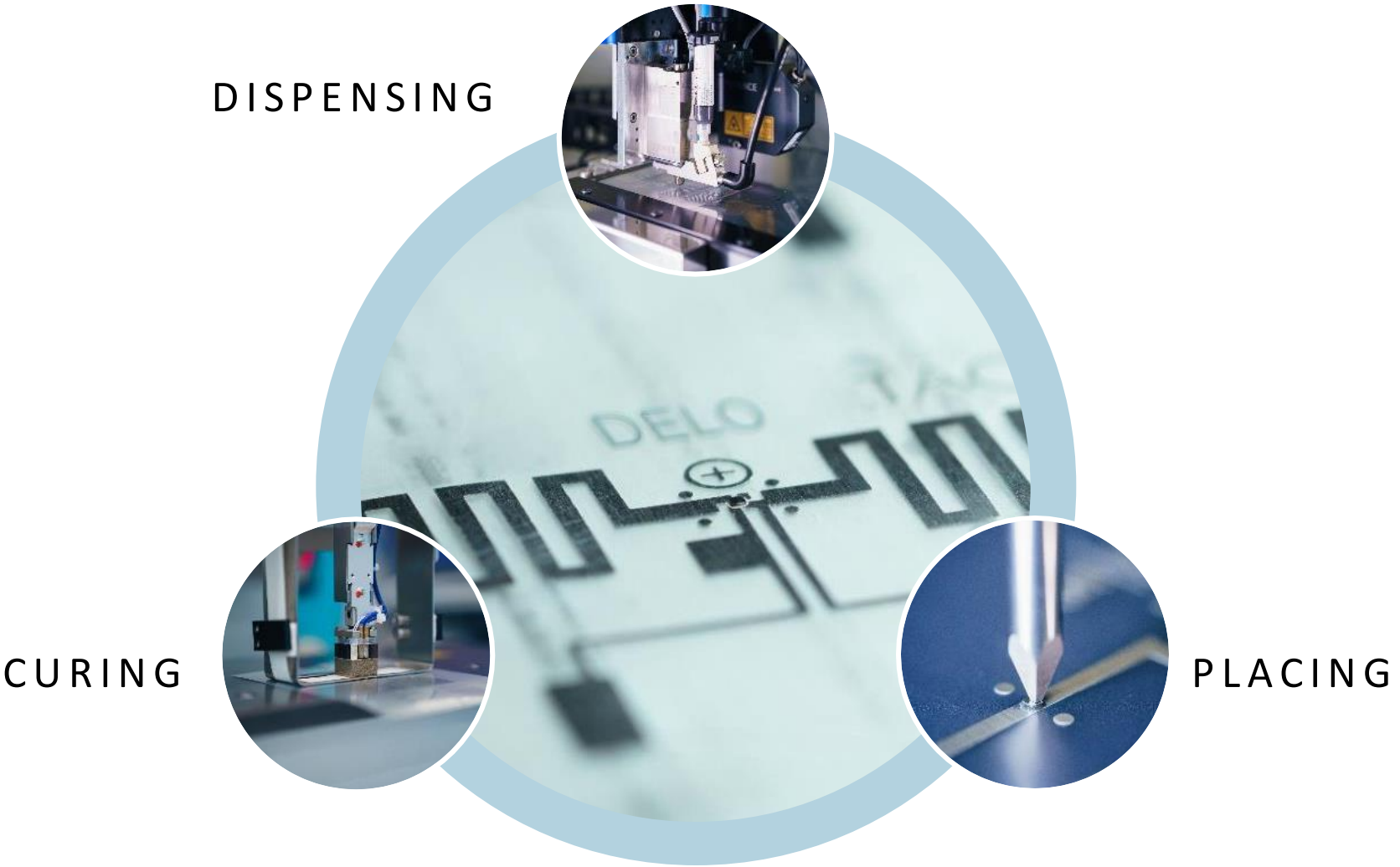


Dispensing

Cleaning of the valve

Dispensing parameter
- Pre-heating temperature
- Number of shots
- Amount of adhesive
- Nozzle / Needle

Rheological characteristics

INFLUENCE FACTOR

FAILURE PATTERN

Bubbles in the fillet

Spreading

Clogging

Satellites

Cleaning of the Valve

RFID ADHESIVES

Depending on the used adhesives different cleaning agents has to be used for cleaning

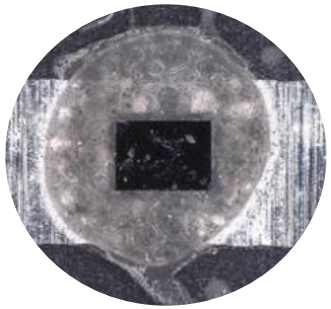
AMINIC ADHESIVES

- All adhesives starting with **AC2** in front
  - DELO MONOPOX **AC2**68
  - DELO MONOPOX **AC2**457
  - DELO MONOPOX **AC2**264
  - …

- **Cleaning agent: BDGA - *Butyldiglykolacetat***

DO NOT USE: Isopropanol / Acetone

– if you use these agents, the adhesive will cure

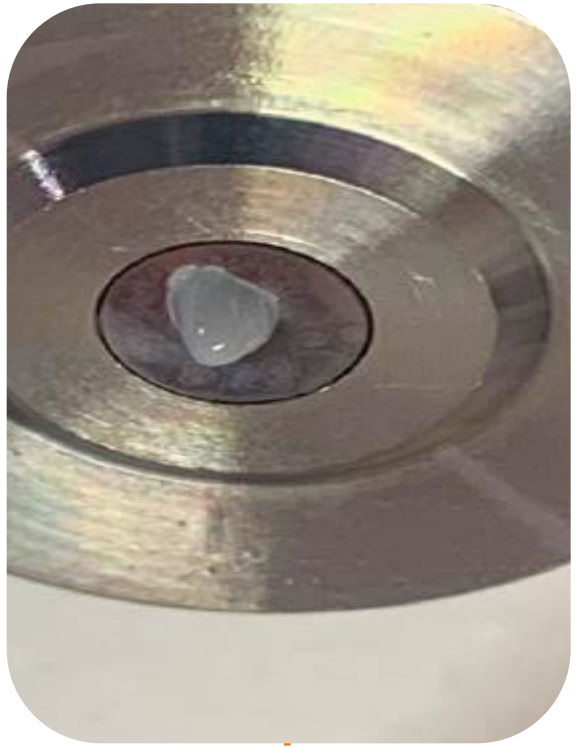


CATIONIC ADHESIVES

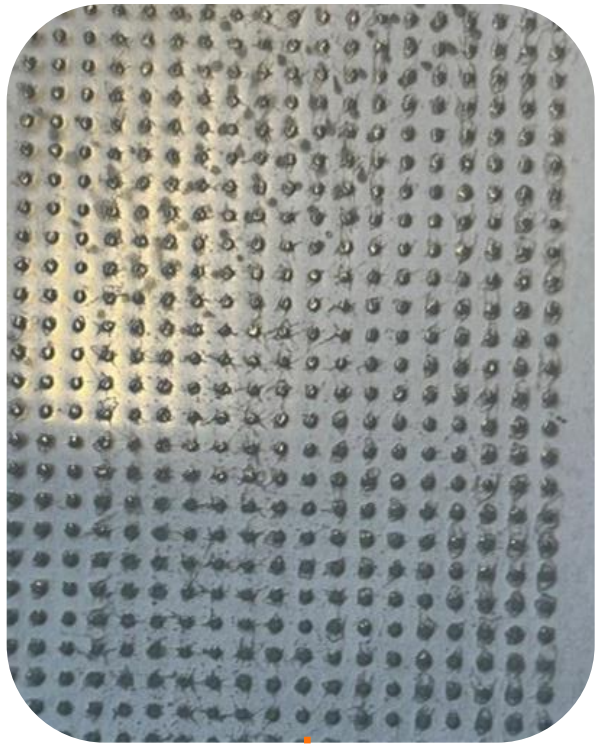
- All adhesives starting with **AC65** in front
  - DELO MONOPOX **AC65**68
  - DELO MONOPOX **AC65**47
  - DELO MONOPOX **AC65**30
  - DELO MONOPOX **AC65**31
  - …

- **Cleaning agent: Isopropanol / Acetone**

Dispensing Parameters: Pre-Heating Temperature



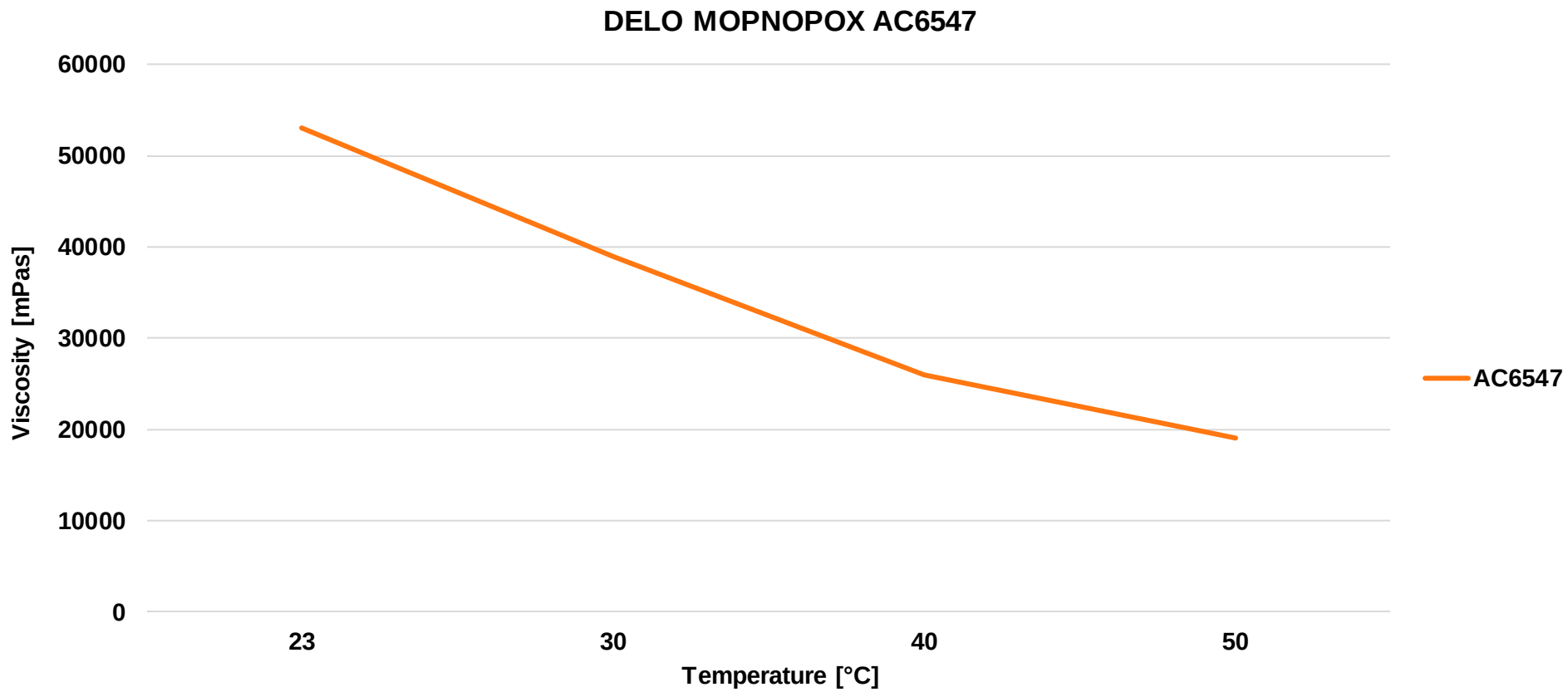
Clogging



Spreading/Satellites

Too high temperatures can cause clogging

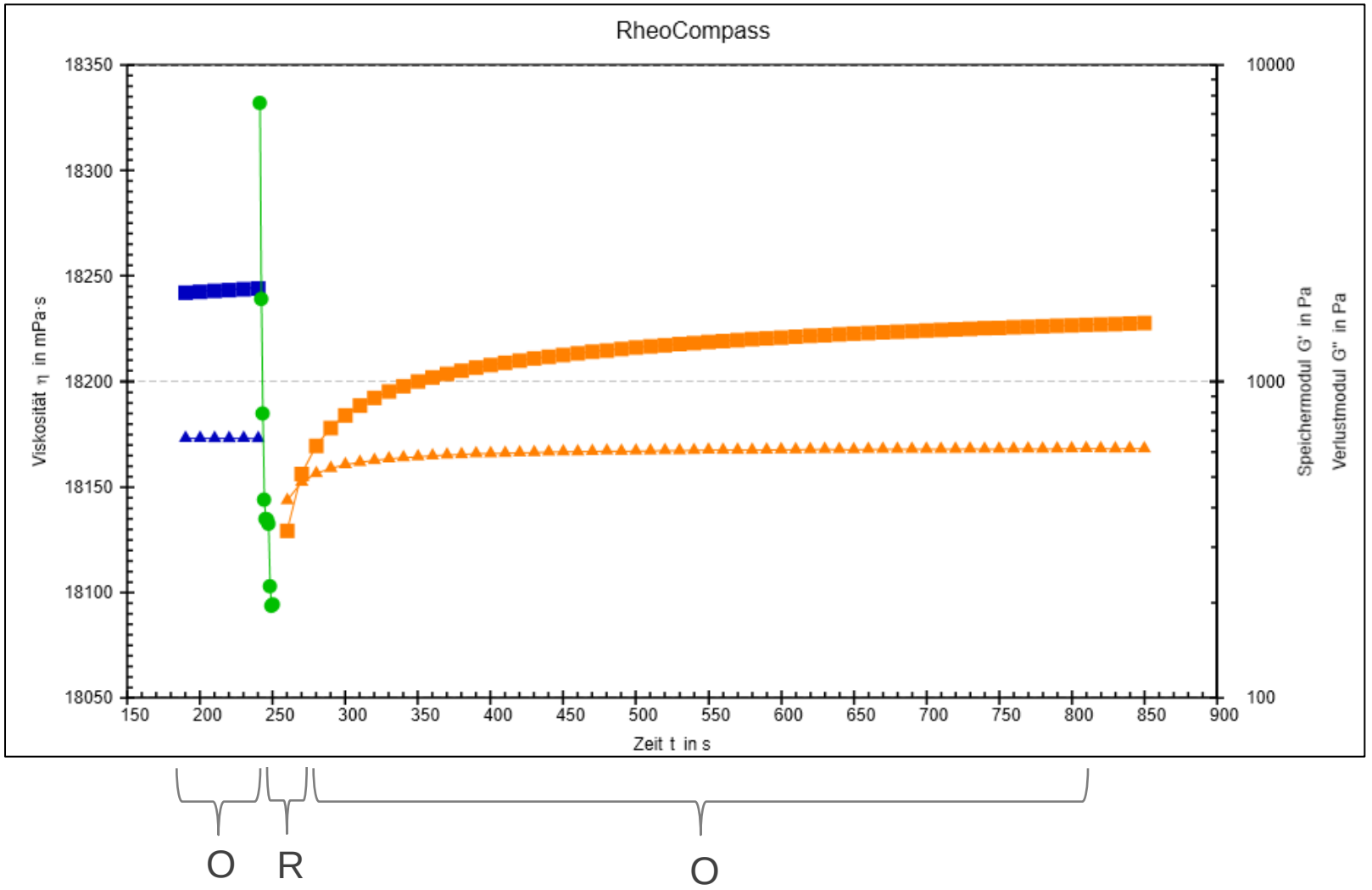
Viscosity Changing Data: Viscosity Over Temperature



Viscosity measured using Rheometer (10 1/s)
RHEO001 @ RT

⇨ Viscosity decreases at higher temperatures

Viscosity Changing Data: Shear Stress

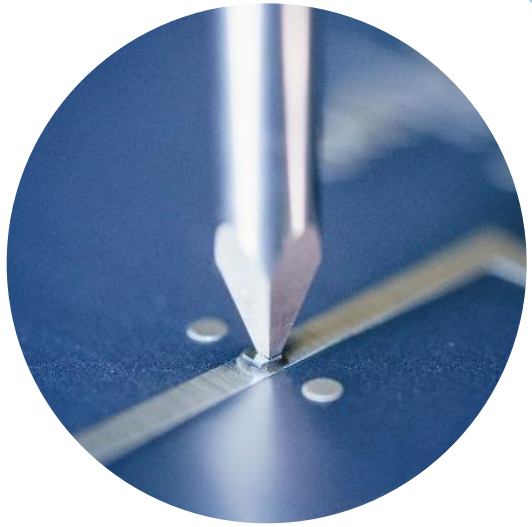


Viscosity decreases when adhesive is dispensed

Placing

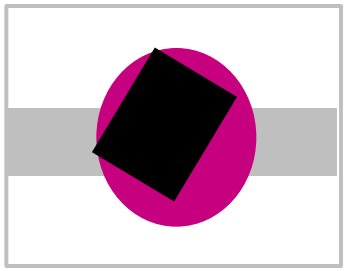
Viscosity of the adhesive

INFLUENCE FACTOR



FAILURE PATTERN

Placing accuracy



Misalignment of die
(No or bad conduction)

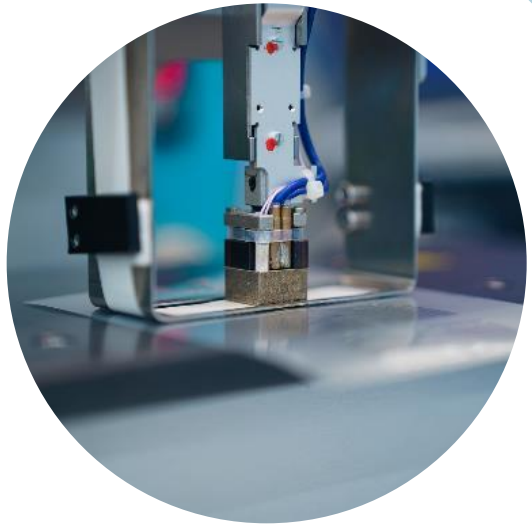
Curing

Curing time

Curing temperature

Bonding Force

INFLUENCE FACTOR



FAILURE PATTERN

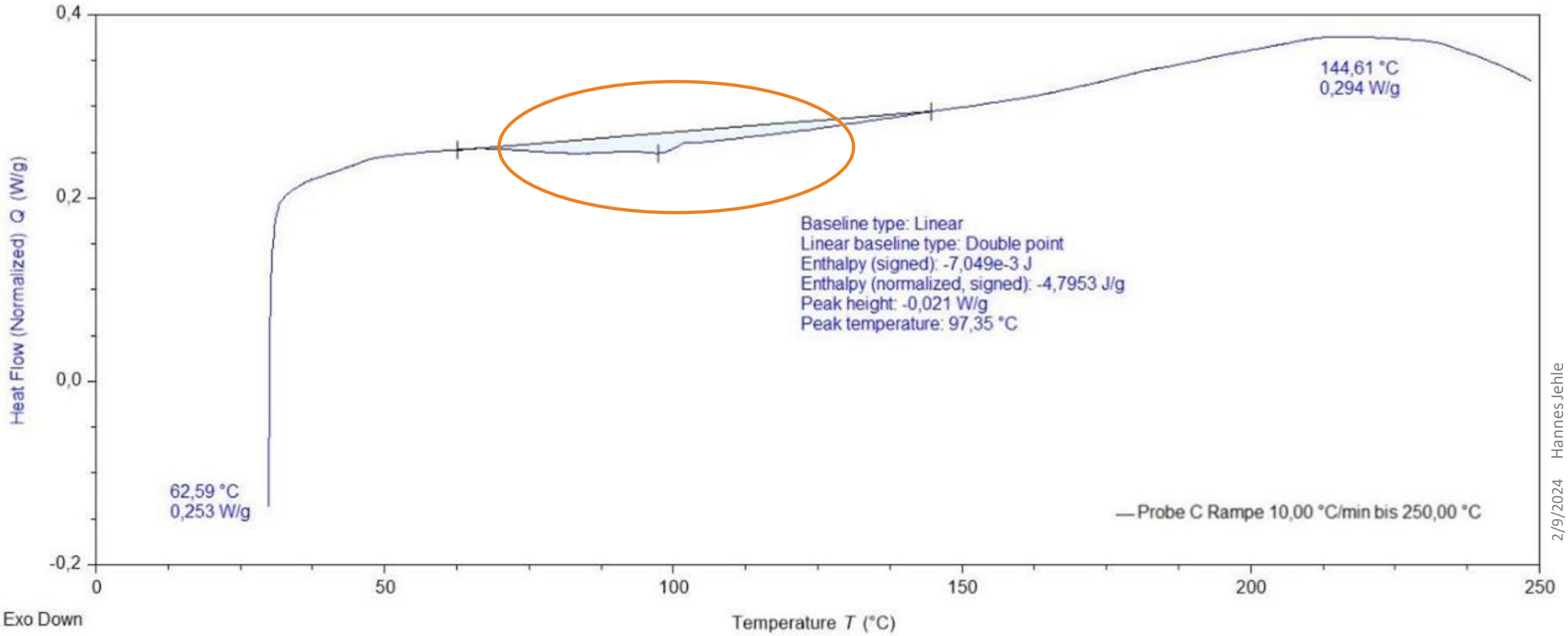
Bad reliability

Cracks

Voids

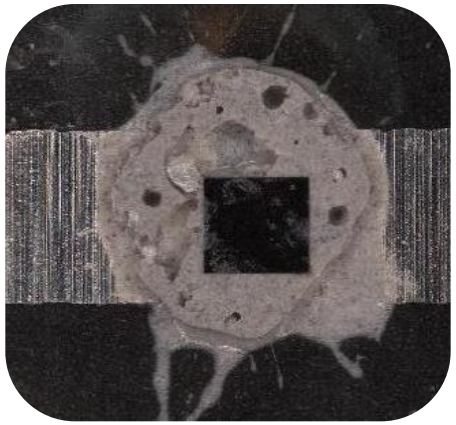
Bad connection

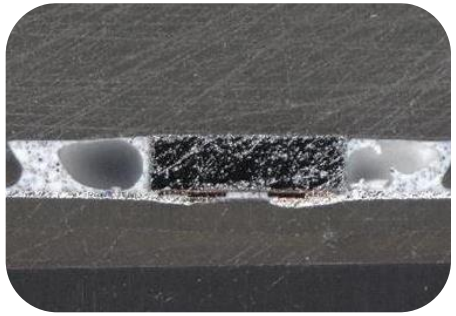
Determination of Curing Degree: DSC Measurement

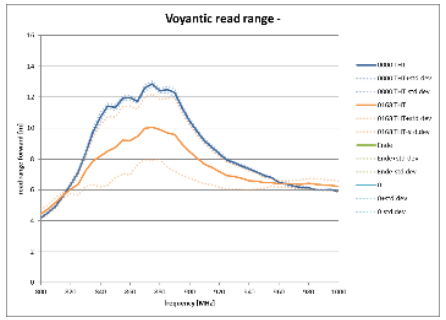


Drop in reliability if adhesive is not fully cured

DELO – Highest Competence in RFID Bonding







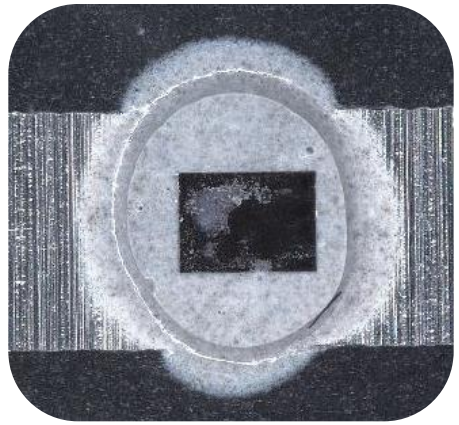
Engineering
R&D
Analytics

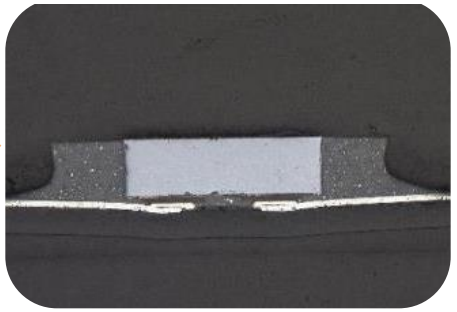
From here

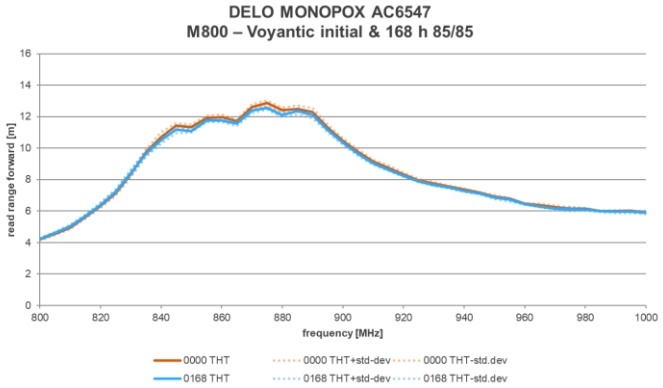
DELO
INDUSTRIAL ADHESIVES

To here

Process
simulation



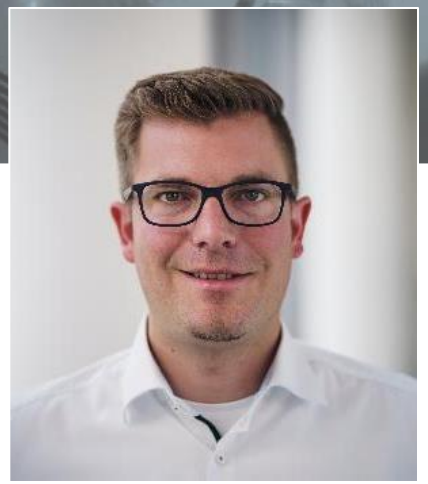




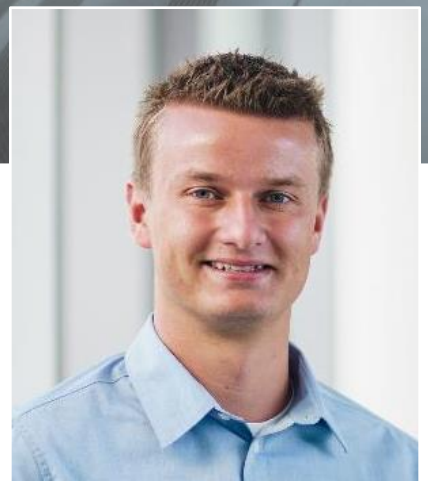
- Strongest support from qualification to HVM and beyond
- More than 15 years of experience

DELOs RFID Team

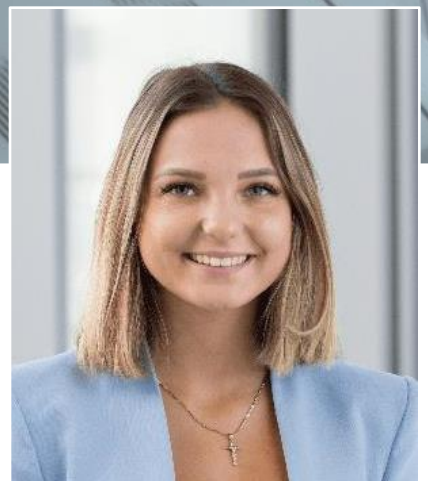
CONTACT OUR TEAM



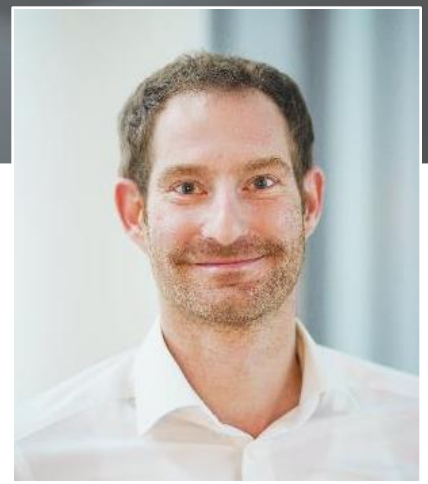
Hannes Jehle
Product Manager



Benedikt Keckeis
Technical Assistance



Katharina Opačak
Application Field Engineer



Dr. Tobias Schmitz
Application Field Engineer

rfid-experts@delo.de

04

Solution: DDA Dry Inlay Assembly Reference Recipes

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DDA Dry Inlay Reference Recipe Goals

1. Accelerate dry inlay assembly recipe development for customers
   - Intended as a starting point to reduce the time and effort for Impinj customers to develop their own optimized production recipe and accelerate the time to HVM
   - Not intended to be a full turn-key solution
2. Give customers a reference for what is achievable and how it was achieved
   - Provide all details on inputs - Inlay details, IC model, and ACP model used
   - Provide DDA assembly machine hardware configuration, operating parameters, configuration files
   - Provide all machine run statistics, monitoring, and output files for the inlay build
   - Provide dry inlay quality testing results
3. Establish a standard for inlay assembly build monitoring & data collection
   - Document the key machine build statistic and output files that are necessary to assess the quality of the build and to determine if/when/what build issues may have occurred
   - Be able to link back inlay quality issues and field failures to production assembly parameter setting and/or variances to production build targets

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Impinj DDA Dry Inlay Reference Recipes

- Reference Recipe publication has started with the Impinj M800 generation of ICs

- Reference Recipes are published for the following configuration:
  - Direct Die Attach to full inlay (Muehlbauer DDA-40K)
  - Etched Aluminum Antenna on PET substrate Inlays
  - One fast cure ACP recipe and one slow cure ACP recipe

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DDA Dry Inlay Reference Recipe Overview

- Definition of the Essential DDA Recipe configuration files and DDA Build Statistic Files
  - Explain what they are, Where they are stored on the machine, What the files contain
  - Document how to Configure & Activate the DDA Vision System Statistics
- List the DDA-40K configurable hardware components and what was used for the build
  - Ejector Needle Model & Dimensions, Ejector Needle Cap model
  - Vermes Jetter model, Jetter Nozzle model & Nozzle opening size
- Description of the DDA Nozzle Cleaning Cycle and the impact on ACP dot size
- Why & How to set a lower and upper limits for epoxy dot area
- Chip, Wafer, ACP and Inlay Specifications
- DDA ACP Jetter settings
- DDA Die Ejection parameter settings

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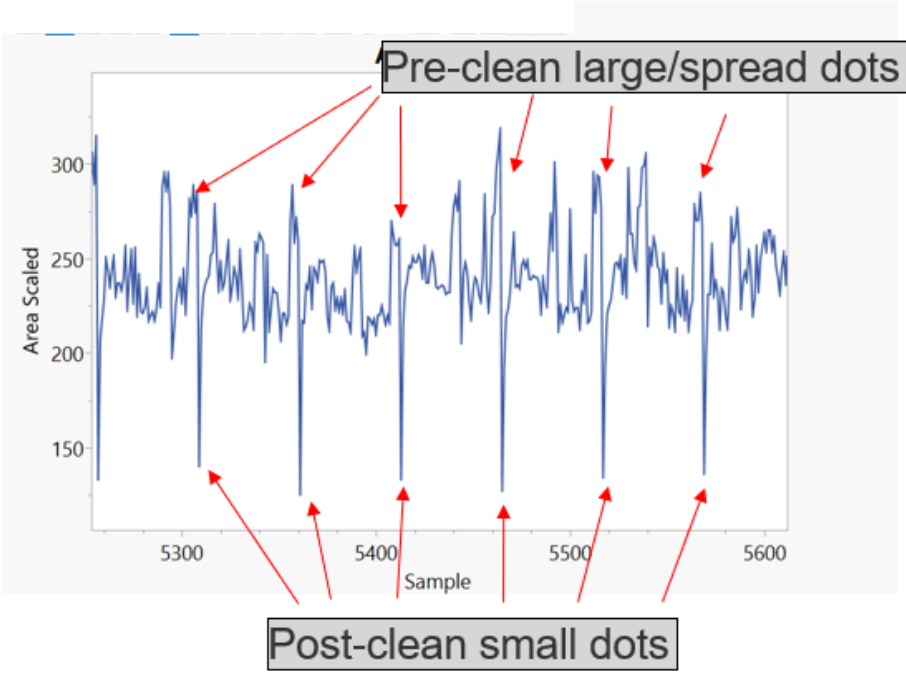
DDA Dry Inlay Reference Recipe Overview

- DDA Final Bonder Settings
- Voyantic Tagsurance Inline Test Setup
- Build Result Summary
- DDA Machine Lot report Summary
- Die Displacement Summary and Details
- Epoxy Jetting Summary and Details
- Assembled Dry Inlay Quality Testing Results
  - Tagsurance Inline Electrical Test Results and Yield
  - Sample Inlay Visual Puck Inspection Results
  - Die Shear Results
  - Voyantic Bendurance Bend Results
  - ALT - THT/TCT Test Results



- All DDA build configuration file and output statistics files for the build can be downloaded with the report

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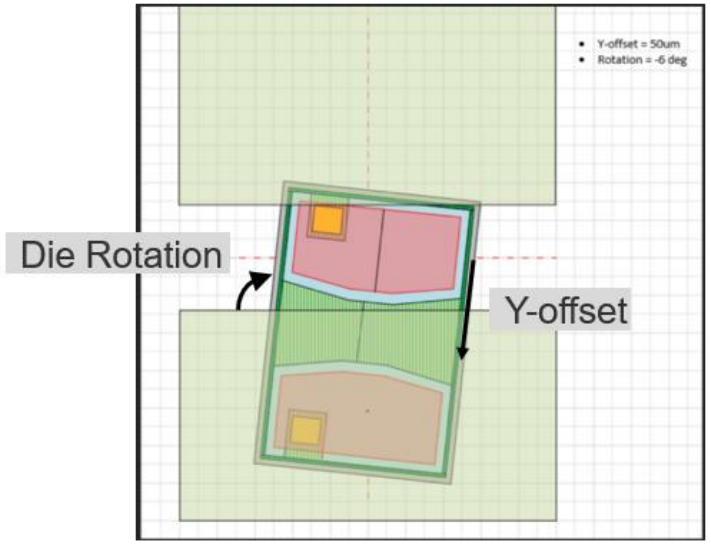
Die Eject Placement Results

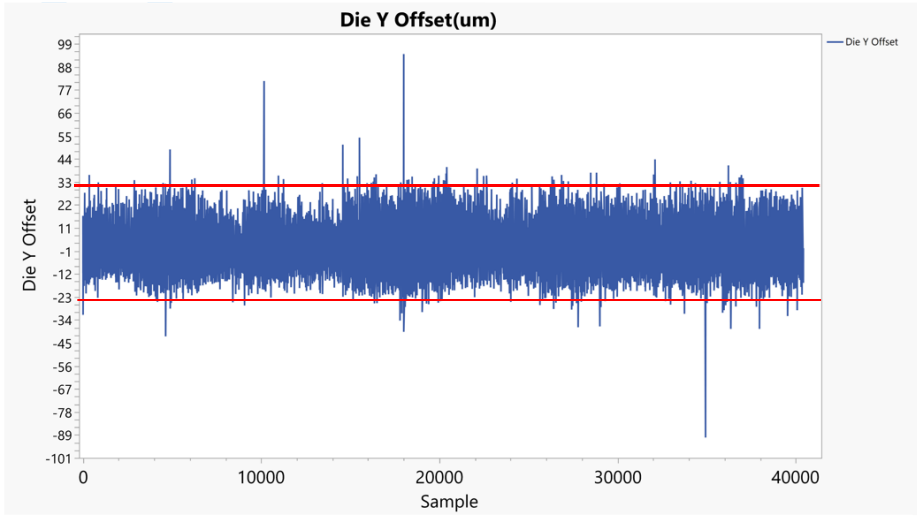
- **Die Y-Offset**

  99.9% of die having an offset between +33µm and -25µm

- **Die Rotation**

  99.9% of die having a rotation between +4.0 degrees and -4.5 degrees





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05

Inline Process Monitoring

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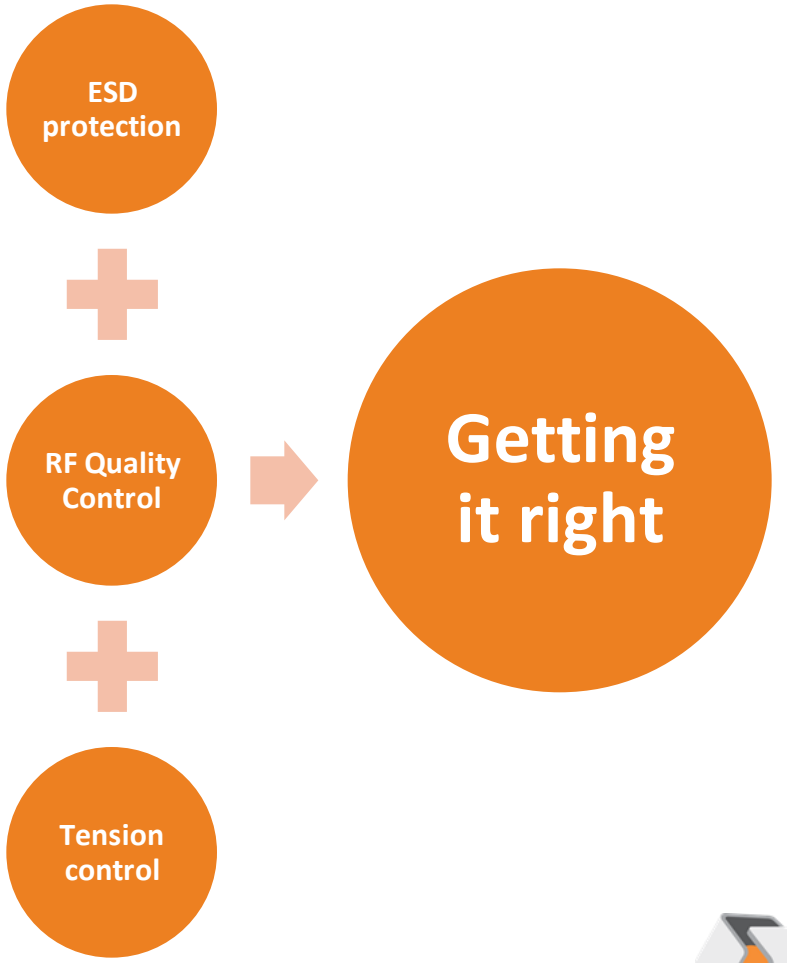
Adding RAIN to a Machine is Our Business as Usual

- If a machine can insert material into a label, it can also insert a RAIN inlay

- If a machine can move labels, it can also move RAIN labels



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Bolt-on Integration of Tagsurance 3

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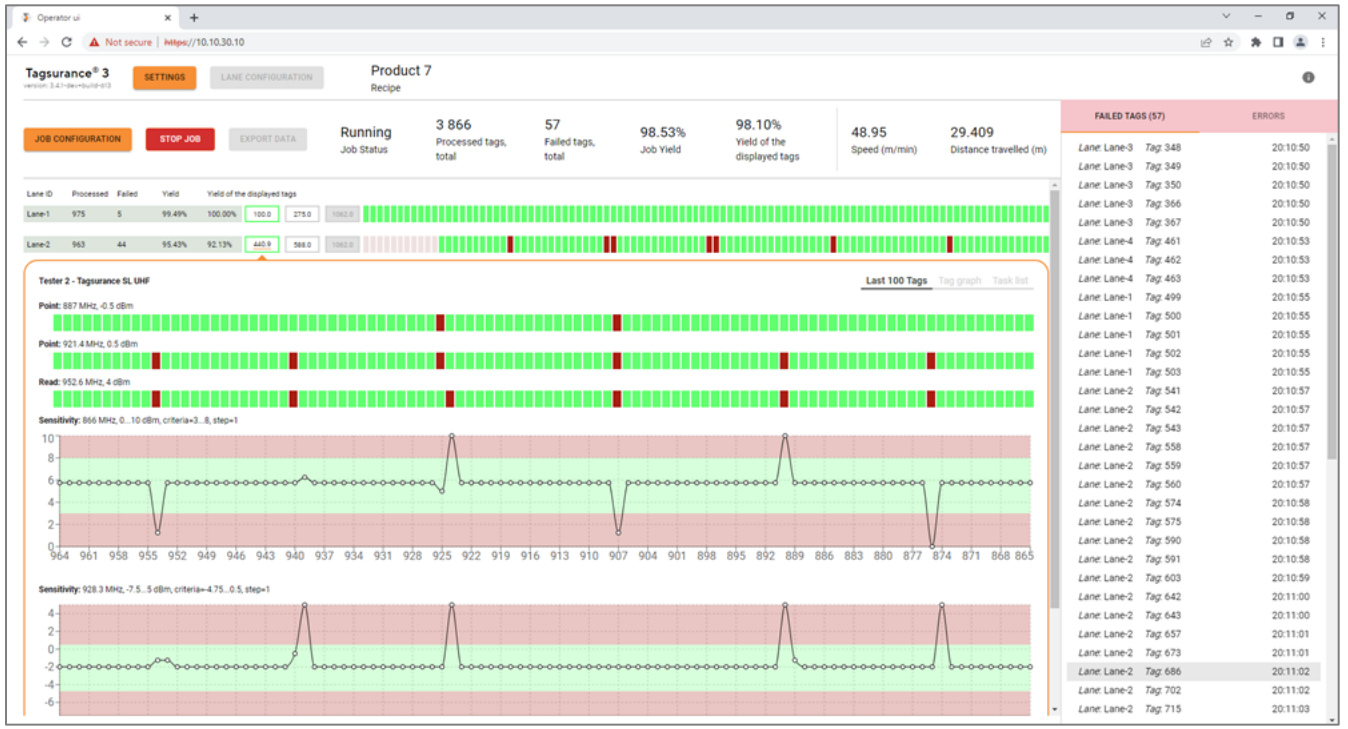
Operation of Tagsurance 3

GUI runs in a browser

- Select product recipe
- Start / Stop
- Real-time visibility to
  - lane status
  - alerts
  - KPIs

Log files are generated automatically



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Lot Management Improves Productivity

Job configuration

CANCEL SAVE

Recipe | Lot | Trigger settings | Action triggers

Lot size
50 000

Results to count
All

Size target
Total across lanes

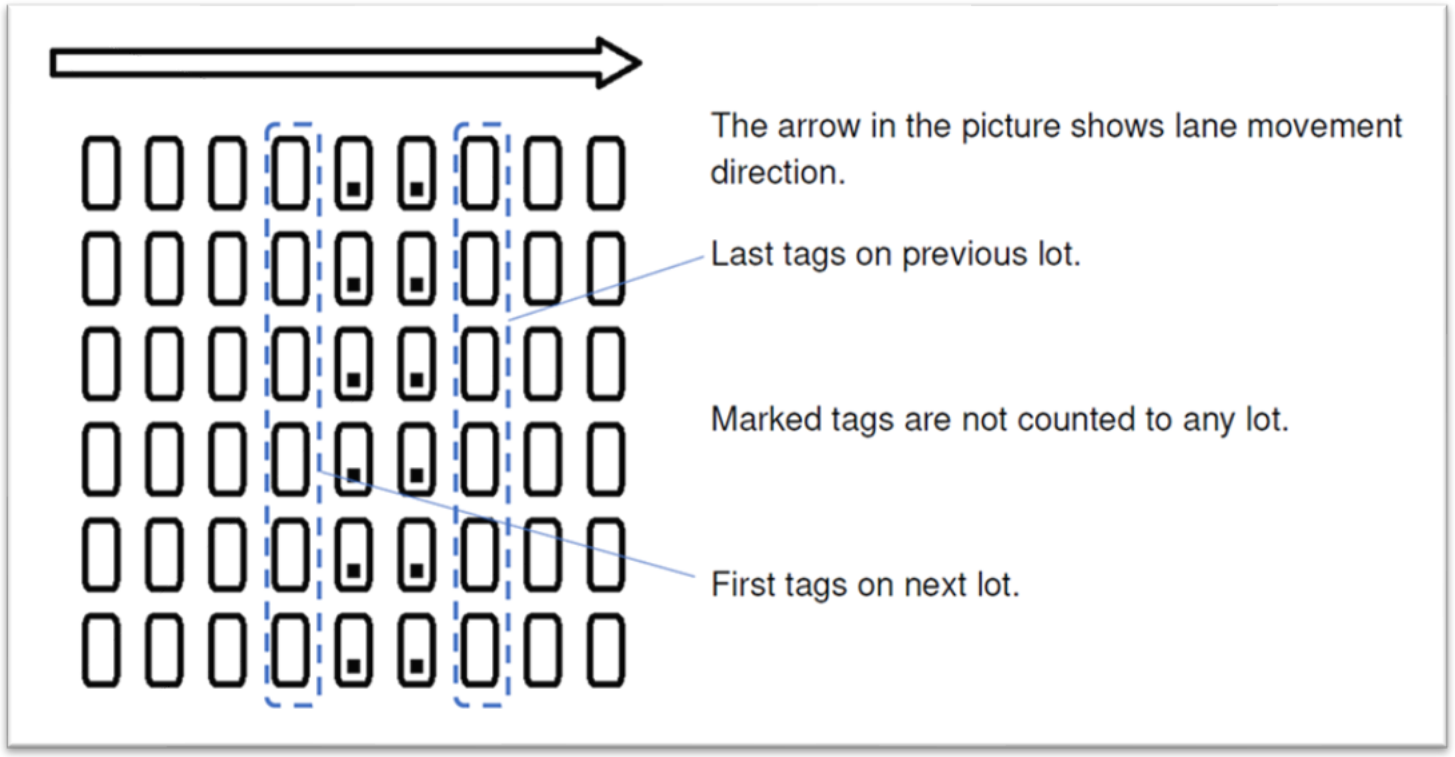
Cut mark enabled

Method
Cut mark between lots

Amount of tags used as cut mark
2

Lot 3 × × Lot 2 × × Lot 1

Direction of tag movement



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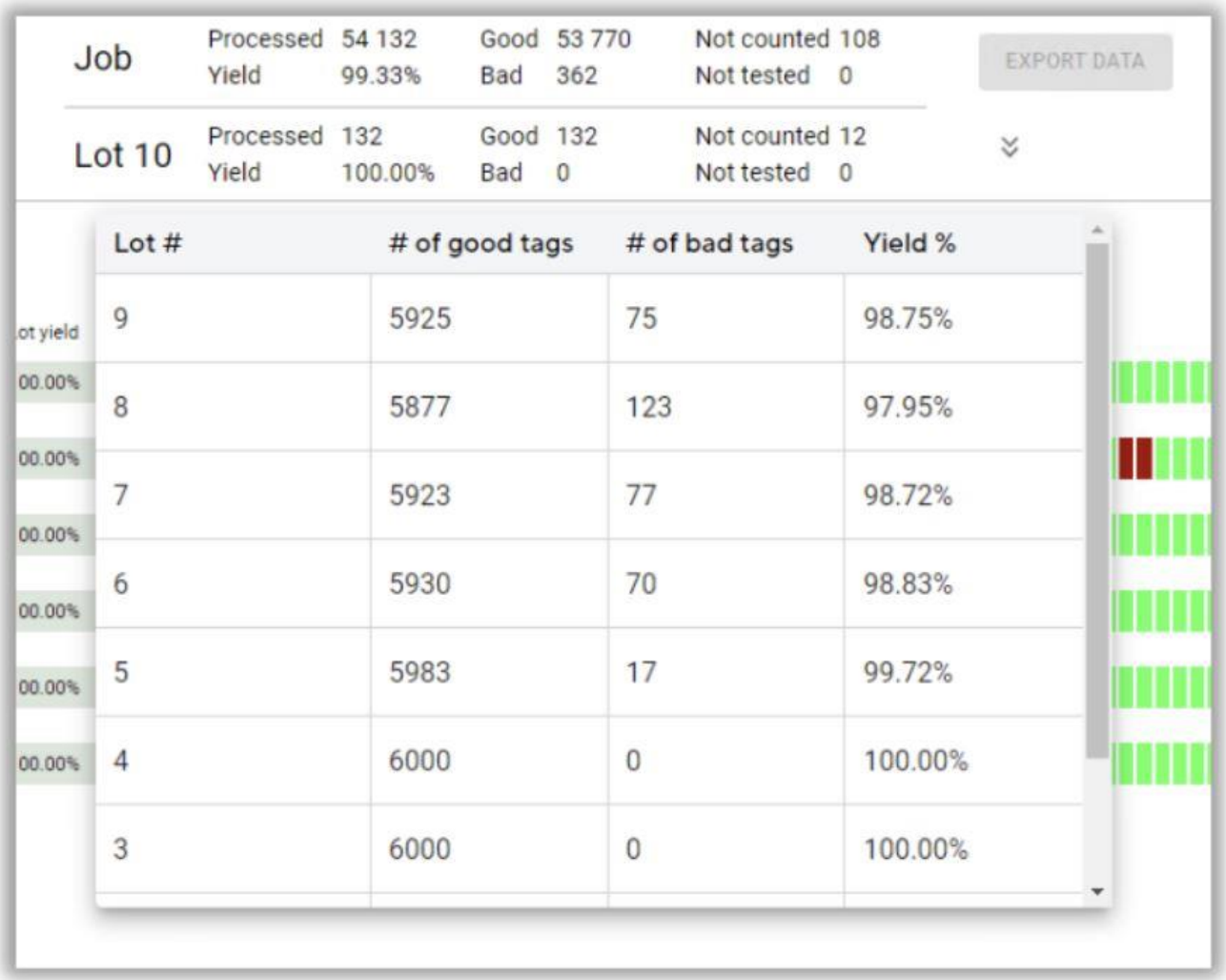
A Job Chopped Into Lots



Job						
	Processed	54 132	Good	53 770	Not counted	108
	Yield	99.33%	Bad	362	Not tested	0

EXPORT DATA

Lot 10						
	Processed	132	Good	132	Not counted	12
	Yield	100.00%	Bad	0	Not tested	0

Lot #	# of good tags	# of bad tags	Yield %
9	5925	75	98.75%
8	5877	123	97.95%
7	5923	77	98.72%
6	5930	70	98.83%
5	5983	17	99.72%
4	6000	0	100.00%
3	6000	0	100.00%

ot yield
00.00%
00.00%
00.00%
00.00%
00.00%
00.00%

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More Information

Product Page: Tagsurance 3
https://voyantic.com/production/tagsurance-3/

Demo Videos
https://voyantic.com/production/tagsurance-3/demo-videos/

Blog: Best Practices for RAIN RFID Label Quality Testing
https://voyantic.com/blog/posts/best-practices-for-rain-rfid-label-quality-testing/

Blog: Lot Management in RFID Tag Production

https://voyantic.com/blog/posts/lot-management-in-rfid-tag-production-essential-machine-requirements/

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We Help Companies to Excel in RFID

Voyantic is the only company in the world focusing 100% on the quality and performance of RFID

Customers

- Technology providers
- Label production machine providers
- Label production machine users
- Solution providers
- RFID end users

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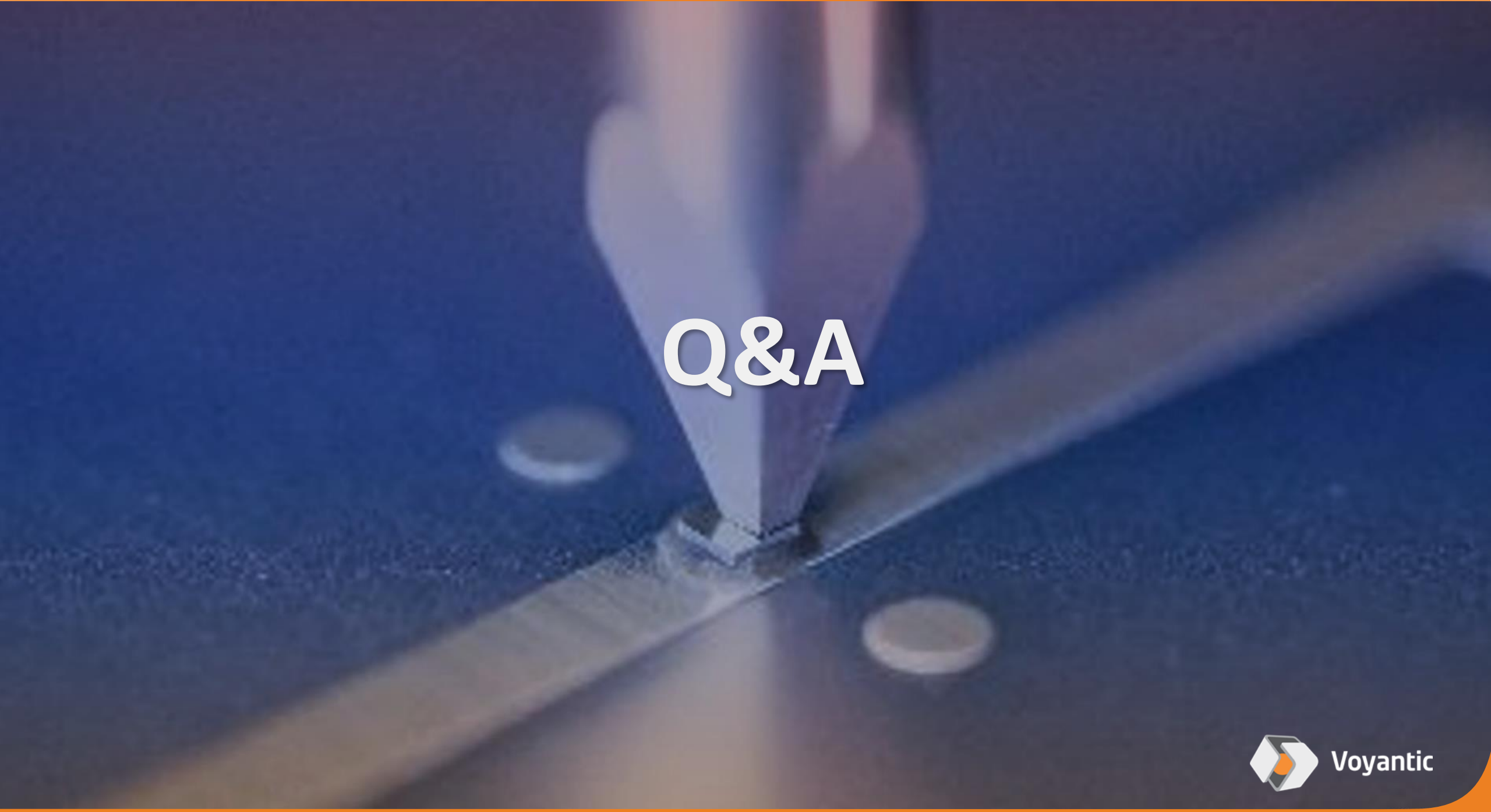
Q&A