Use of flash lamps to achieve non-equilibrium soldering and assembly using conventional solder alloys

Rudy Ghosh, PhD
Technical Program Lead

Outline of the talk:

1. Flexible hybrid electronics –Why?
2. Flexible/ printed electronics manufacturing challenges.
3. Using light as an energy source.
4. Differentiating curing vs reflow.
5. Photonic soldering – application notes.
6. Tool description.

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Form Factors : Automotive Industry

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Form Factors : Electronics vs Consumers

ELECTRONICS

NOVACENTRIX

Form Factors : Electronics vs Consumers

ELECTRONICS

Real world

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Innovations in Materials - Substrates

Base materials need to be flexible, stretchable

FR4

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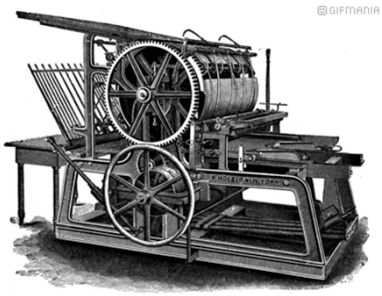
Printing Technology – Mature, Flexible, Non-Intrusive



~ 1500 ad → Present

< 100,000 copies per hour!

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Innovations in Post Processing – Photonic Curing

INKS - NEED THERMAL ANNEALING

SUBSTRATES- THERMALLY UNSTABLE

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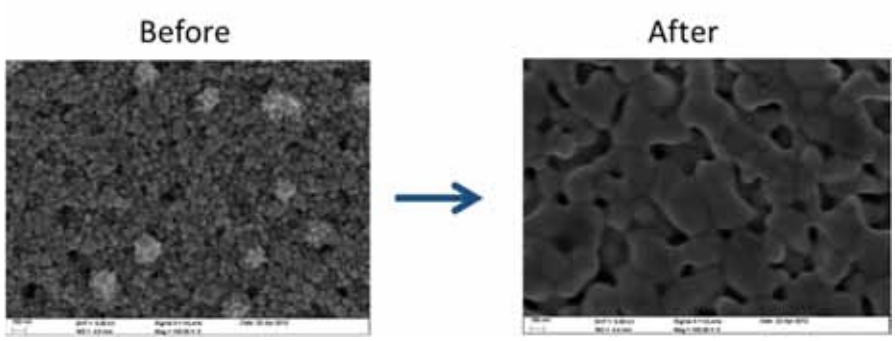
Innovations in Post Processing – Photonic Curing

INKS - NEED THERMAL ANNEALING



SUBSTRATES- THERMALLY UNSTABLE

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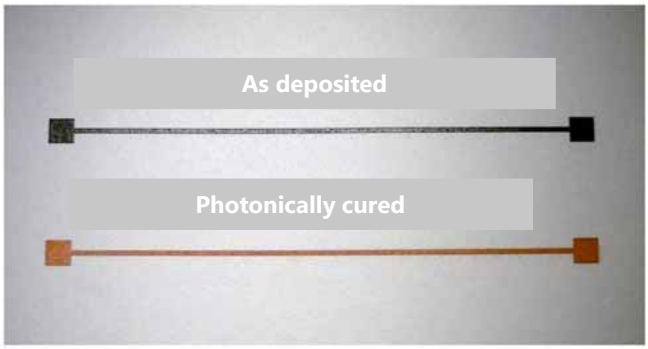
Innovations in Post Processing – Photonic Curing

INKS - NEED THERMAL ANNEALING



Type of ink materials:
Copper
Copper oxide
Silver
Carbon

Type of ink (printing techniques):
Screen
Inkjet
Flexographic
Gravure
Aerosol

SUBSTRATES- THERMALLY UNSTABLE

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ENABLING FLEXIBLE HYBRID ELECTRONICS

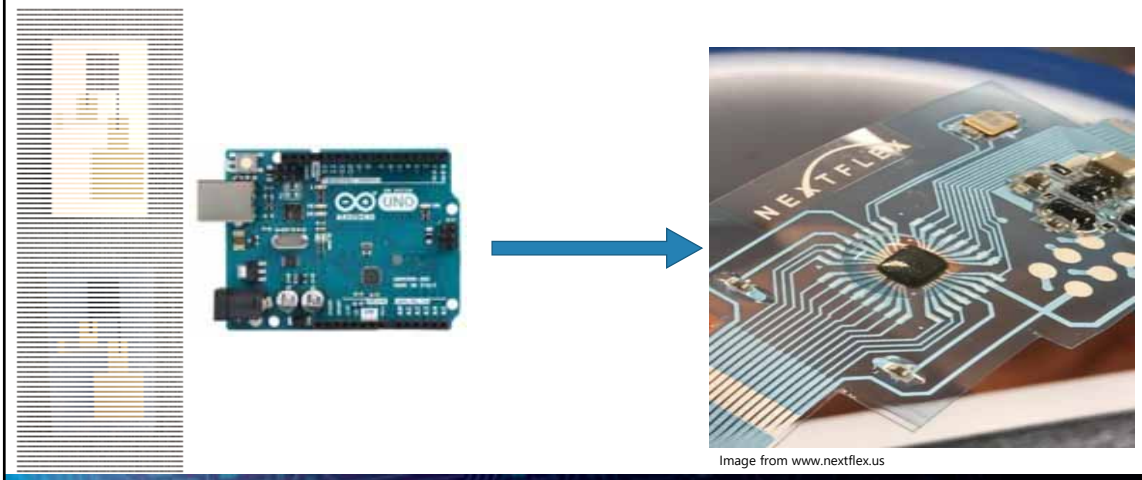

Image from www.nextflex.us

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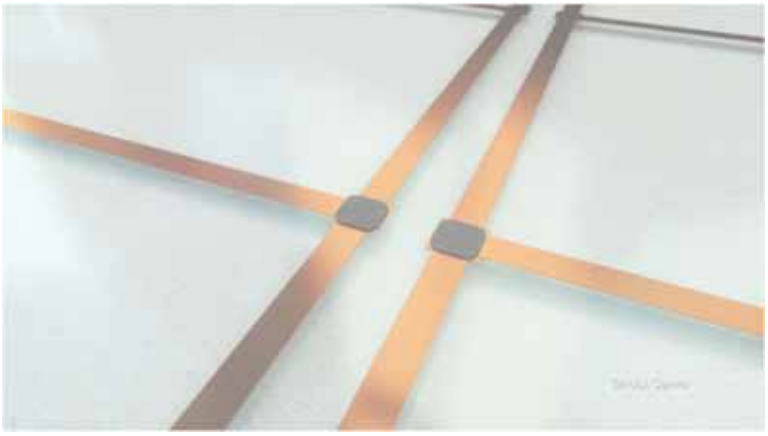
Photonic Soldering – Enabling Flexible Hybrid Electronics

Standard electronics packages – Conventional Solder – Economical, Flexible Substrates



<video>

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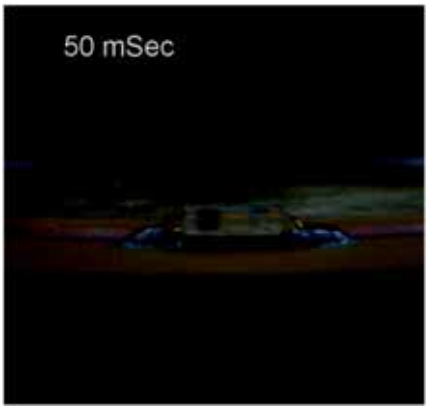
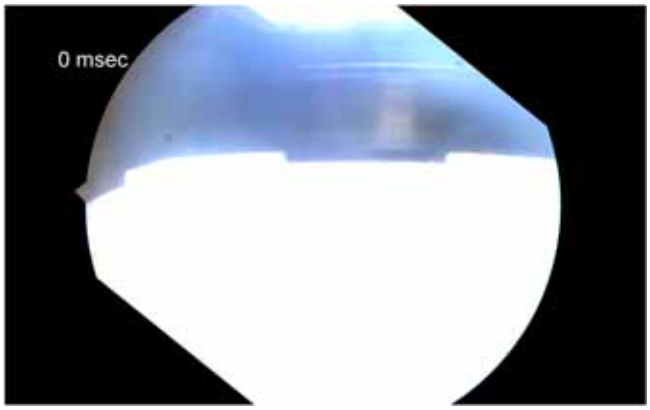
Photonic Soldering – Enabling Flexible Hybrid Electronics

Standard electronics packages – Conventional Solder – Economical, Flexible Substrates





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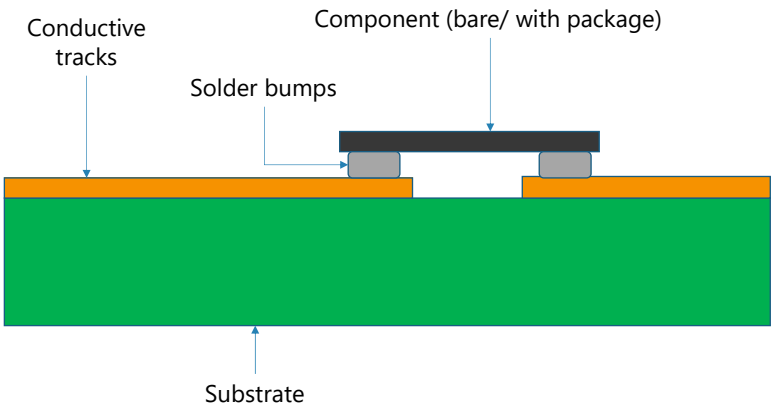
PulseForge Soldering - Differentiators

Looking forward – differentiating our technology

Spatial selectivity
- Thermally sensitive substrate (LED arrays on PET)
- Thermally sensitive component (Sensors, batteries)
- Thermally sensitive regions (interconnects)



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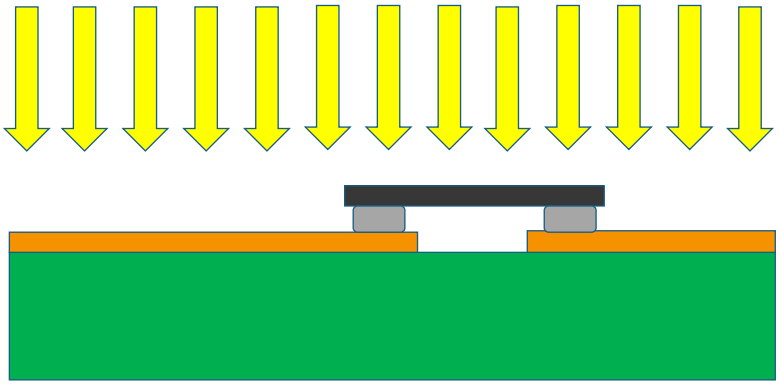

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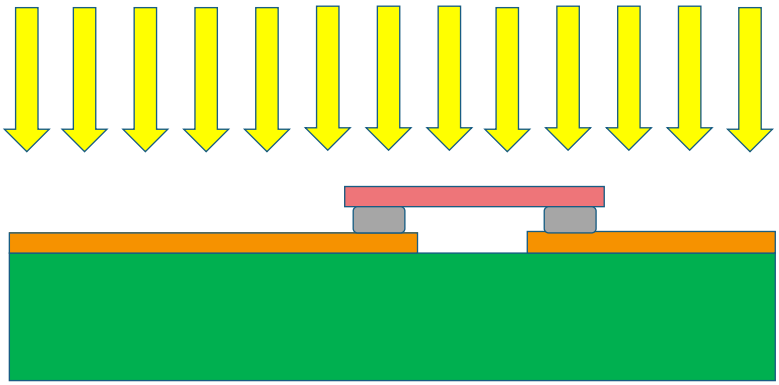

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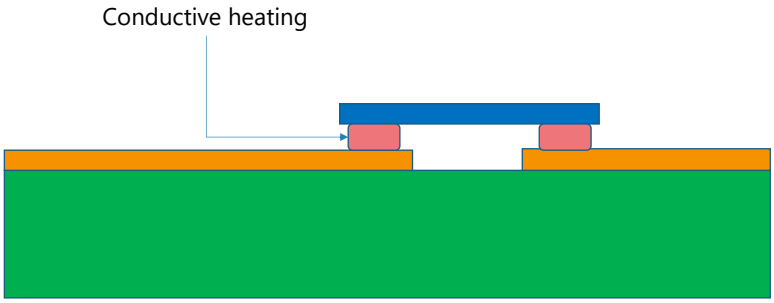

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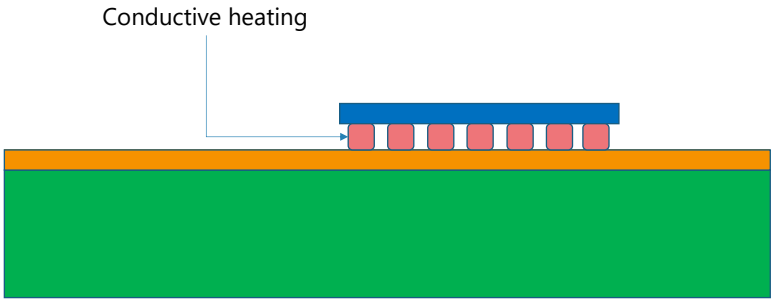

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PulseForge Soldering - Differentiators

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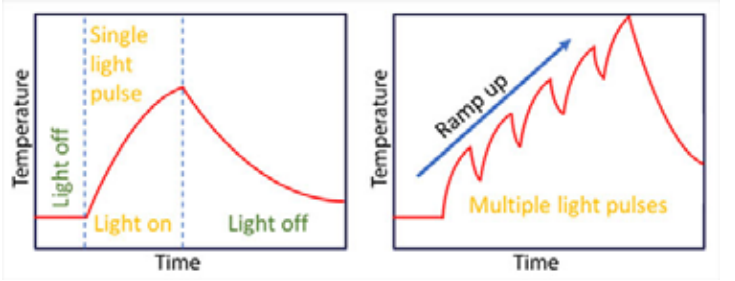

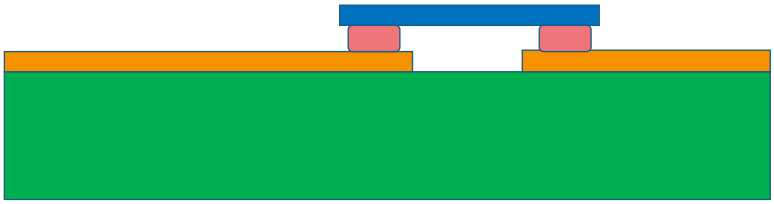

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PulseForge Soldering - Differentiators

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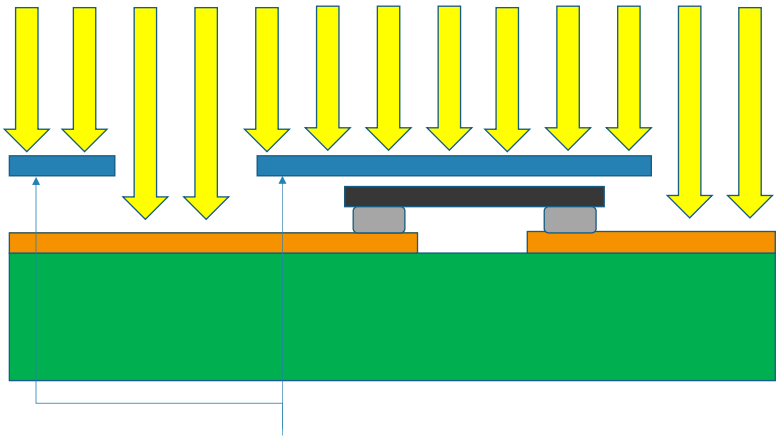

Aluminum mask with laser cut openings

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PulseForge Soldering - Differentiators

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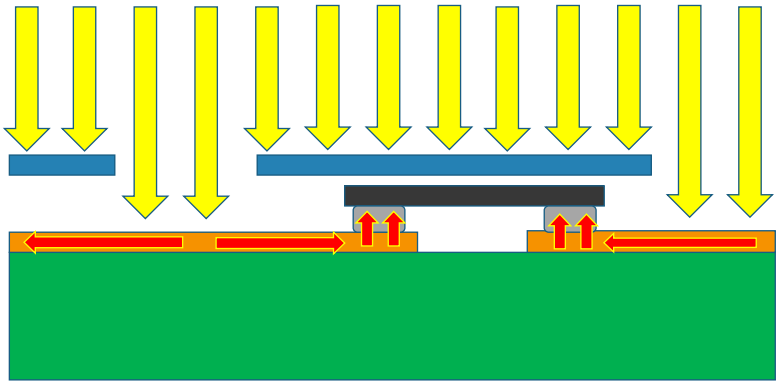

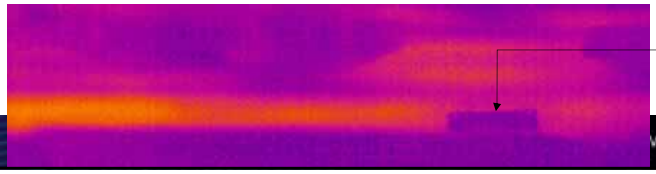

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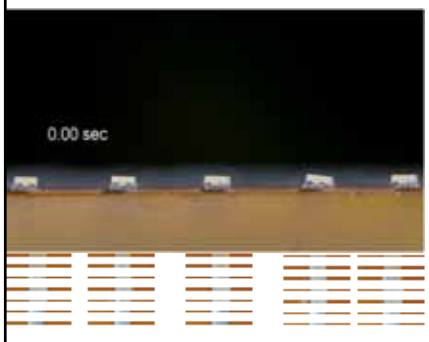
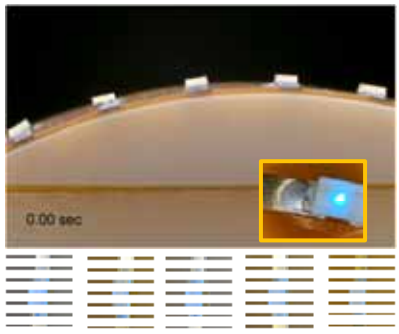
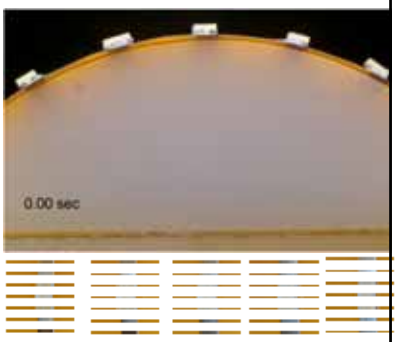
Photonic Soldering – Enabling Flexible Hybrid Electronics

Standard electronics packages – Conventional Solder – Economical, Flexible Substrates







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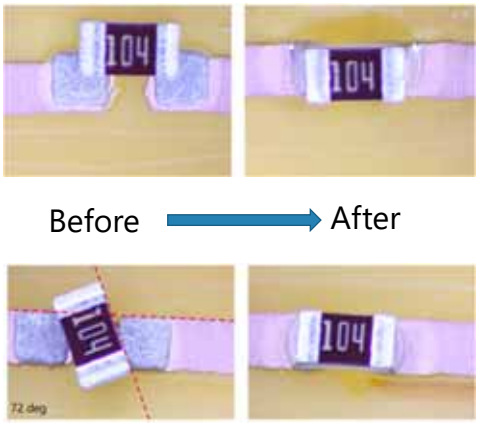
Photonic Soldering – Enabling Flexible Hybrid Electronics

Standard electronics packages – Conventional Solder – Economical, Flexible Substrates



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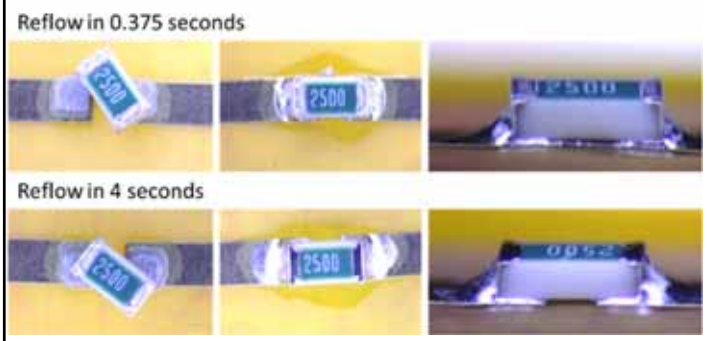
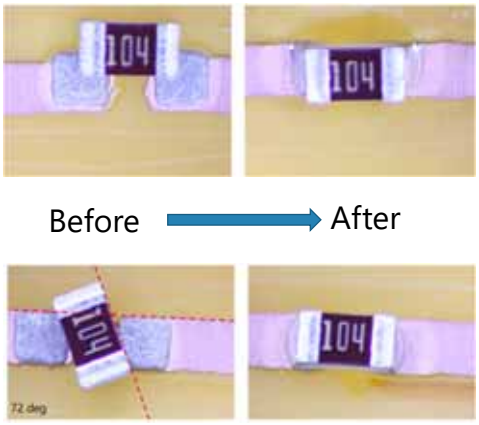


SAC305 lead-free no-clean solder paste



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Photonic Soldering - Differentiators

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Looking forward – differentiating our technology

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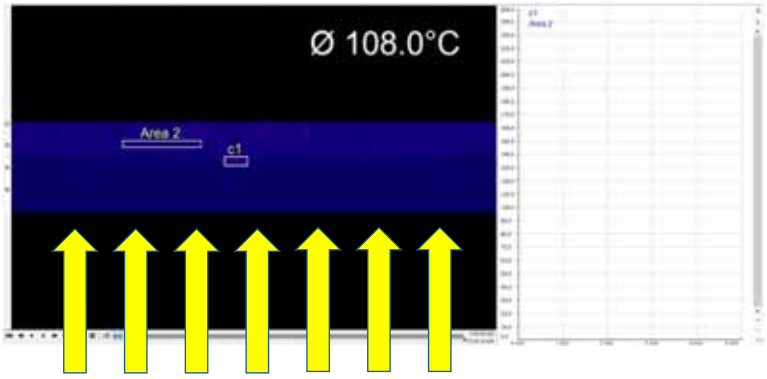
<video>



Direction of light

In the plot, Area2 is the PET substrate while c1 is a 0603 chip resistor.

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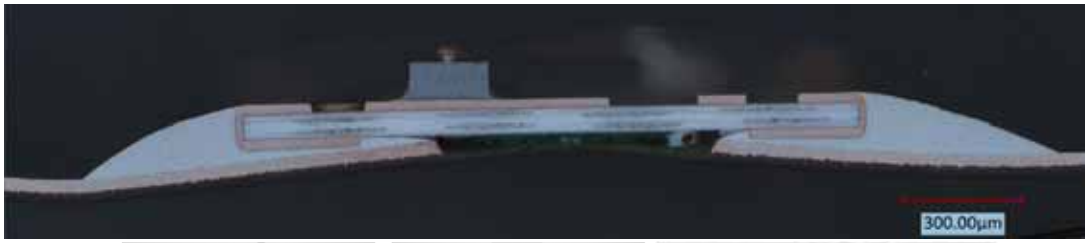
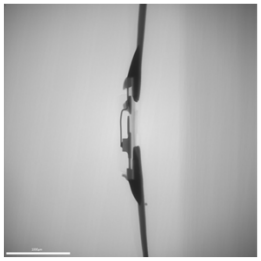
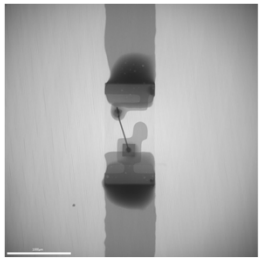
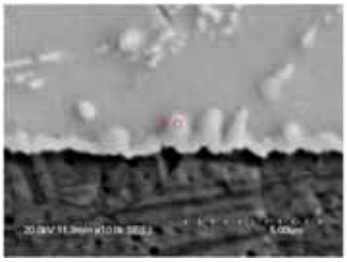
Optical, X-ray, Inter-metallic inspection of solder joints









SAC305 lead-free no-clean solder paste

X-ray images show very low void volume

Intermetallic layer thickness ~ 2 microns

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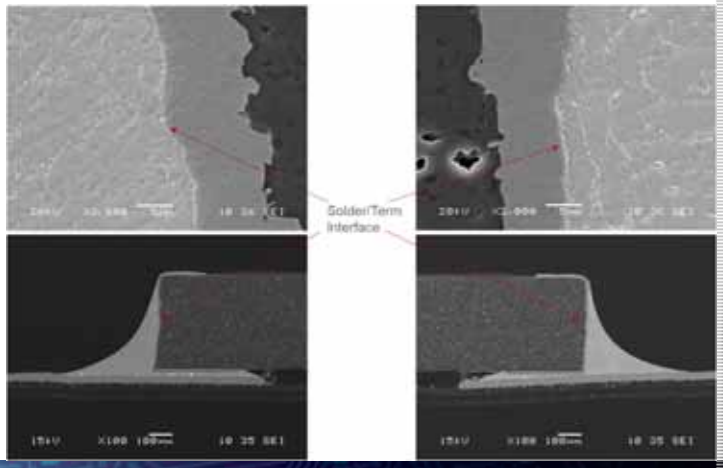
X-ray, Inter-metallic inspection of solder joints



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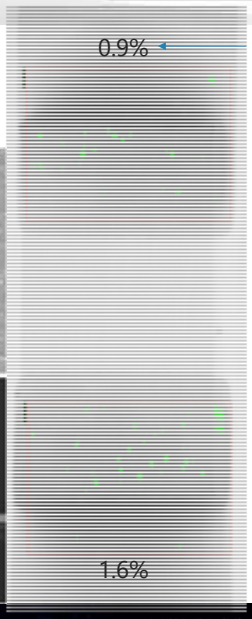

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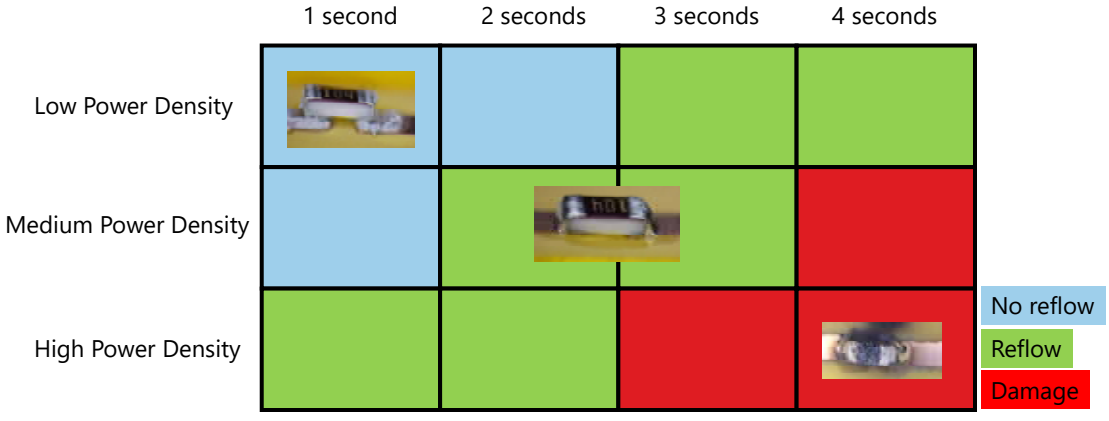
Process Development Matrix

Process Development: Power Density vs. Time



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Process Development Matrix

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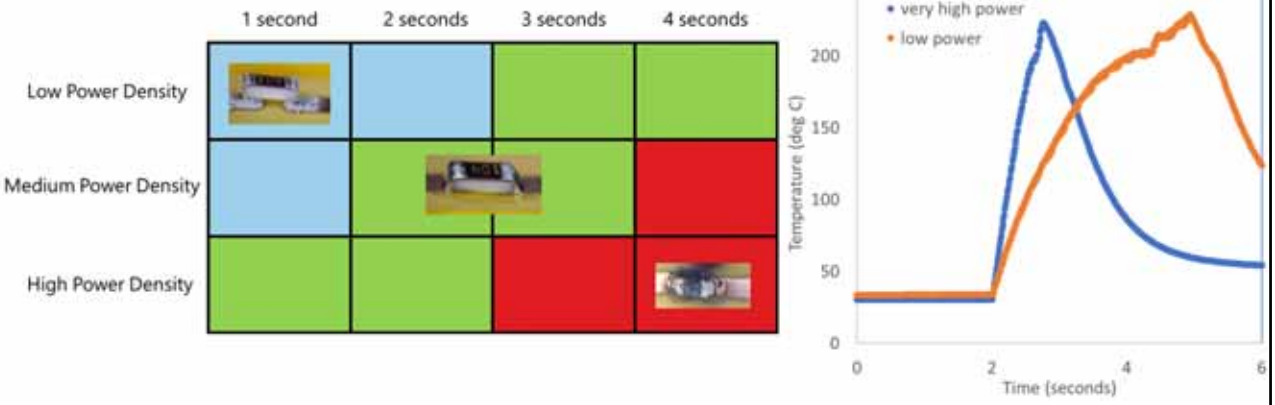

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Process Development Matrix

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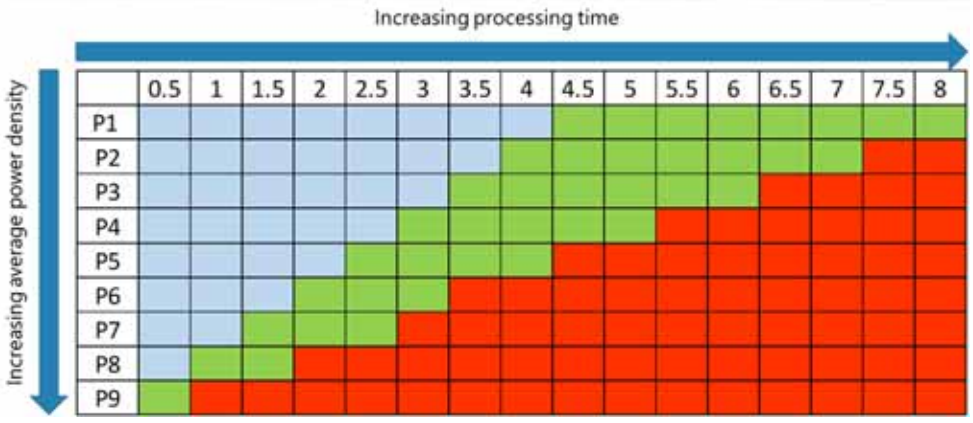

- Thermally stable substrates
- Larger process window
- Higher mix of components
- Closer to equilibrium processes

- Thermally unstable substrates
- Very small process window
- Low mix of components
- Far from equilibrium processes

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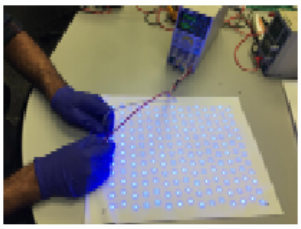
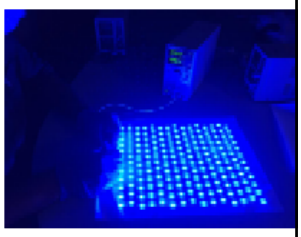
Calling all product designers!

Soldering on Aluminum on PET

Medical Wearables





R2R manufacturing

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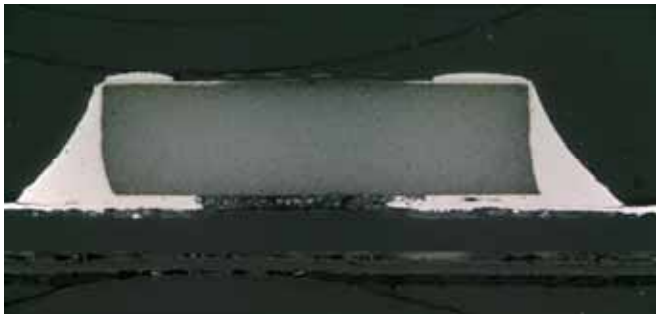
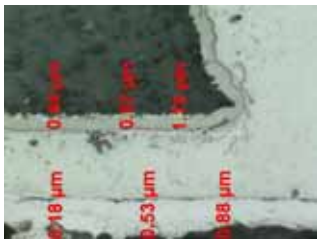
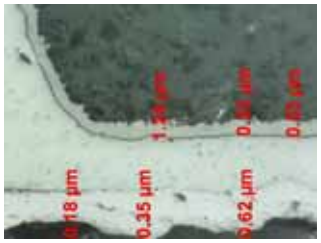
Materials Data for Soldering on Al/ PET using SAC305

Soldering on Aluminum on PET



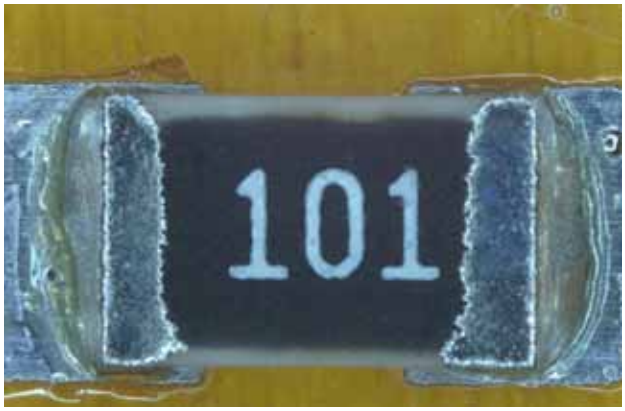




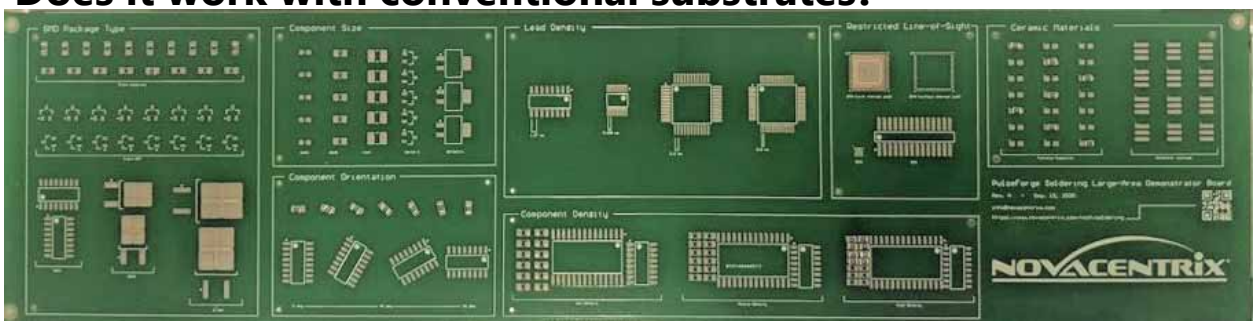
Intermetallic thickness shown in red

Materials Data for Soldering on Al/ PET using SAC305

Soldering on Aluminum on PET



Does it work with conventional substrates?



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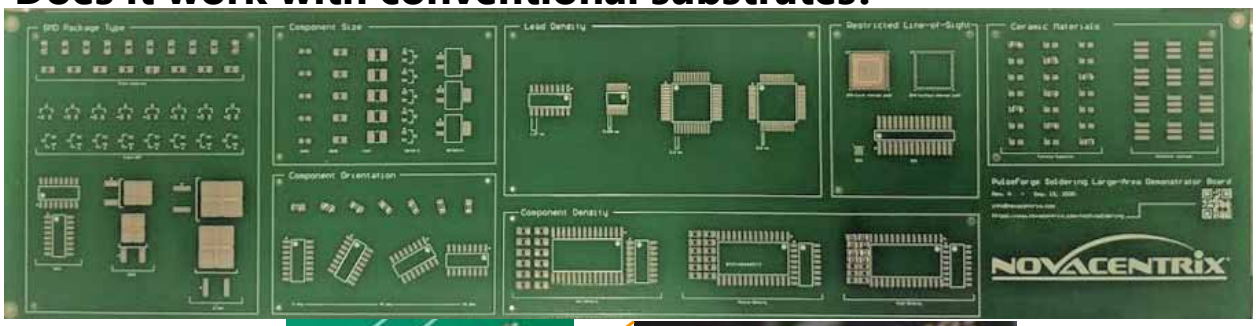

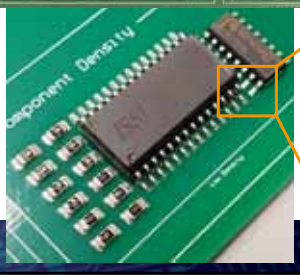

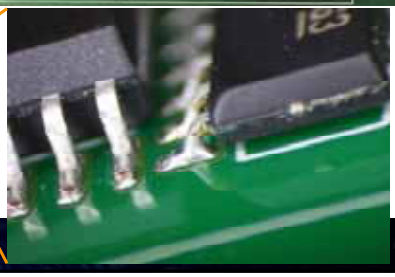

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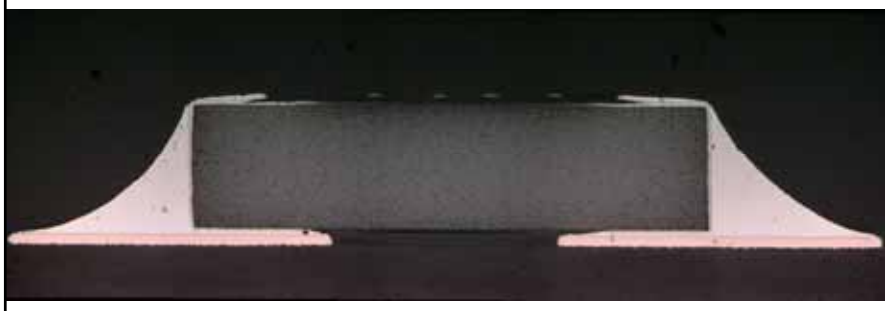
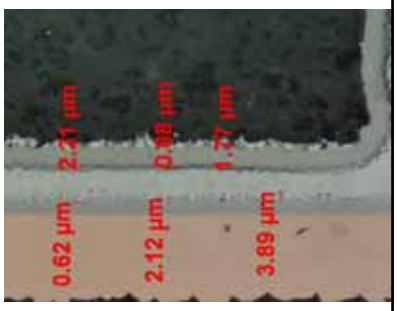
Materials Data for Soldering on FR4 substrate using SAC305





Intermetallic thickness shown in red

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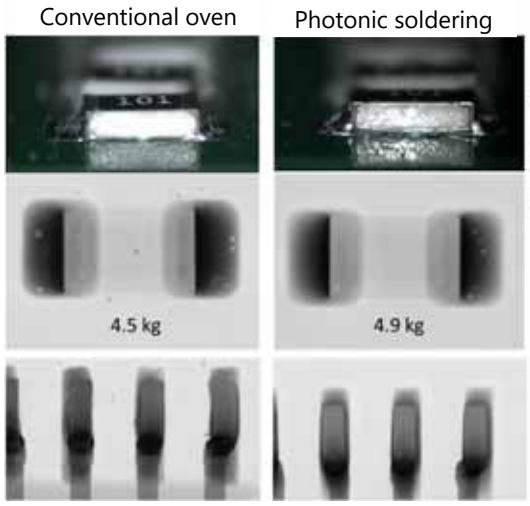
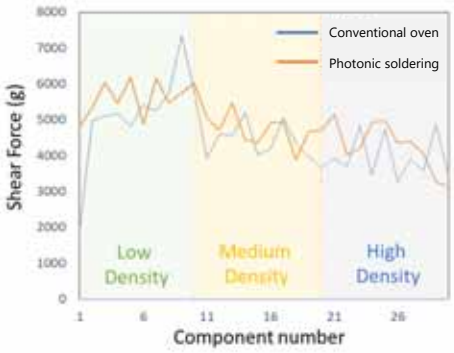
How does it compare to conventional reflow processes?





Comparing optical, x-ray and shear strength data of conventionally soldered (235C for 120 seconds) vs photonically soldered (med power for 3 seconds) soldered components of various sizes on FR4.

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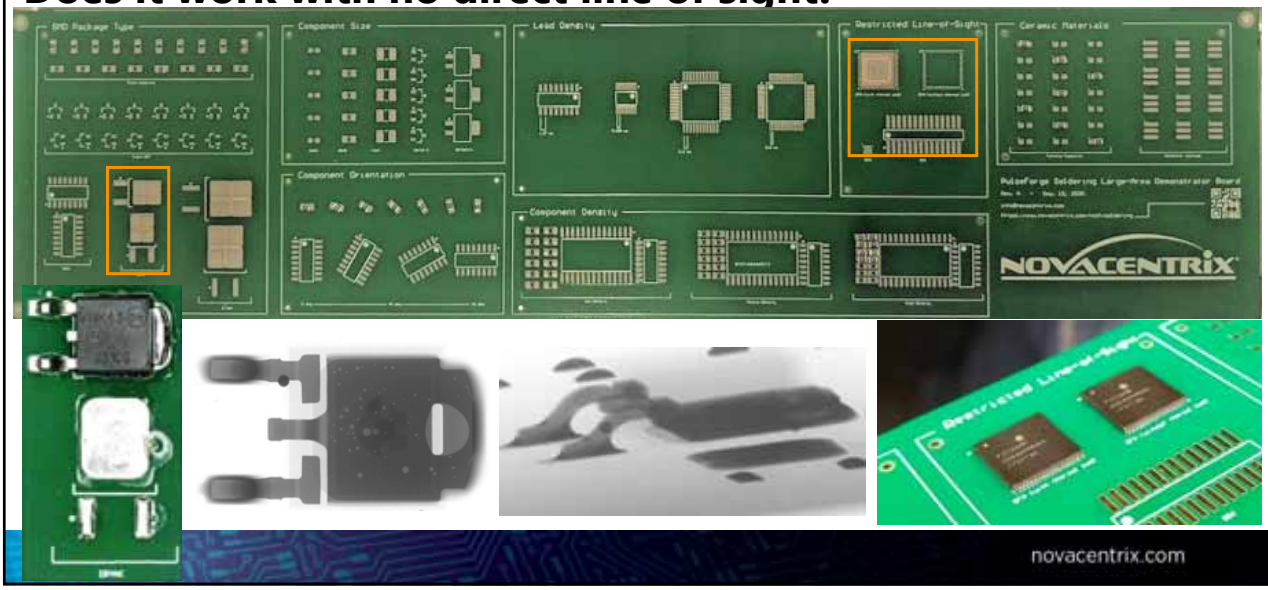
Does it work with no direct line of sight?



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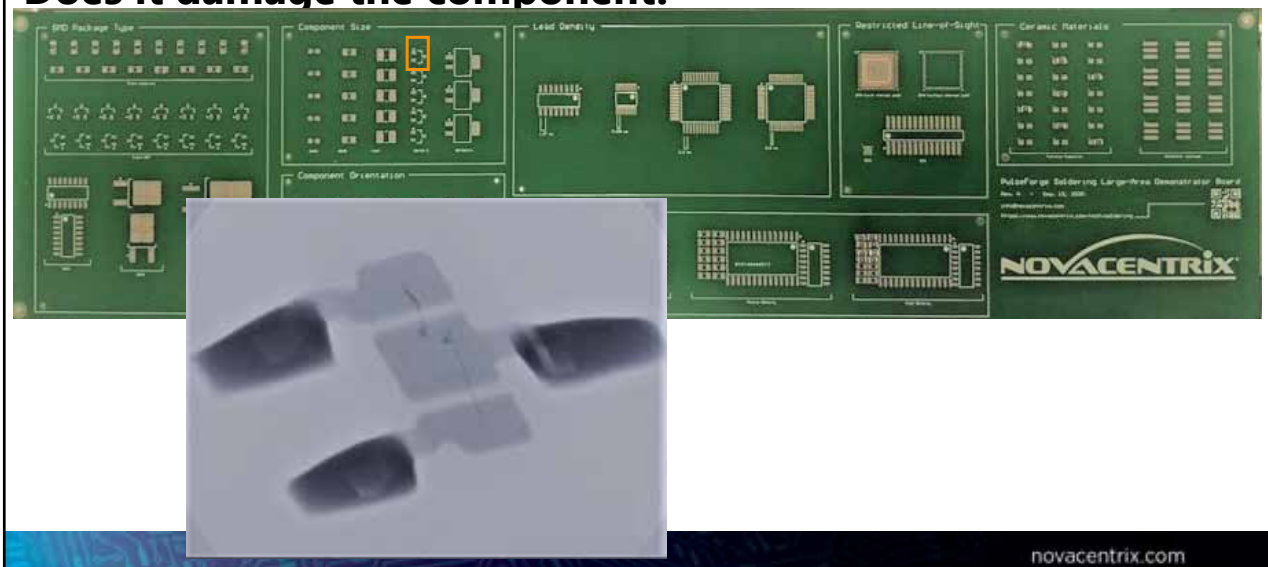
Does it damage the component?



Tool and Customer Lab Virtual Tour

Production scale

Batch scale

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Thanks!

Rudy Ghosh, PhD
Technical Program Lead
Email: rudy.ghosh@novacentrix.com

Stan Farnsworth
Chief Marketing Officer
Email: stan.farnsworth@novacentrix.com

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