Material Technologies for Power Electronics

3D-PEIM 2023

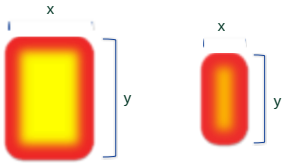
Joe Hertline
Product Manager
Indium Corporation
jhertline@indium.com

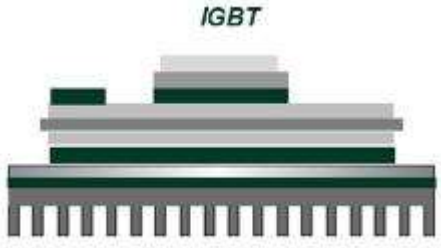
Power Module Design Trends

Reliability is Key

Power Densities

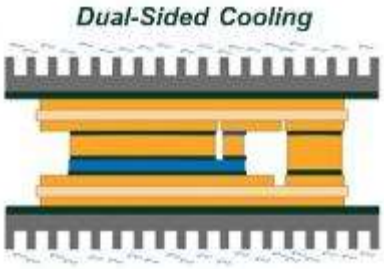
- Higher voltages 10-50V
- Smaller packaging footprints

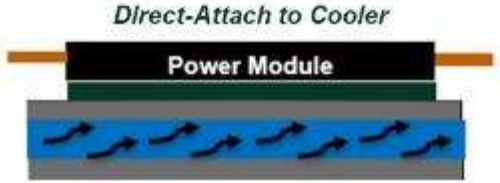




Switching Speeds

- High frequencies with wideband gap semiconductors: Si SiC GaN
- Efficiency gains with reduced losses





Junction Temperatures

- Operating ranges 125 ➡ 200ºC
- Extended thermal cycles 1,000-6,000, AQG324

Materials technologies are a key factor in power module design and manufacturing to meet emerging performance and packaging requirements

We are a premier manufacturer and supplier of advanced materials

We develop, manufacture, and market:

- Solders
- Electronics assembly and packaging materials
- Pure indium, gallium, germanium, and tin
- Alloys and inorganic compounds

We offer a closed-loop reclaim system for these metals.

Our scientists and engineers work closely with our customers to:

- Increase yields
- Improve customer satisfaction
- Increase revenues
- Reduce defects
- Deliver high value and return on investment

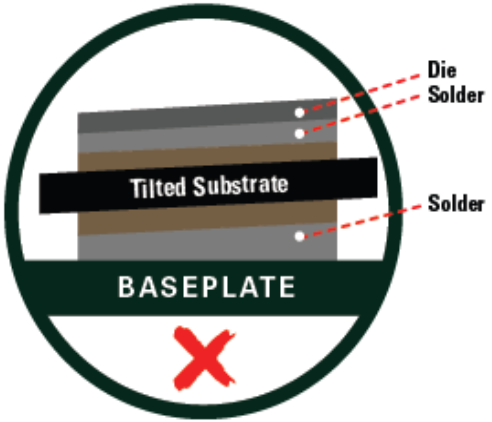
Soldering Reliability Considerations

The Challenge:

Uneven bondline thickness

Assembly tilt and variation

Stress concentrations



Reduced fatigue resistance

Premature lifecycle failures

Uneven stress distribution

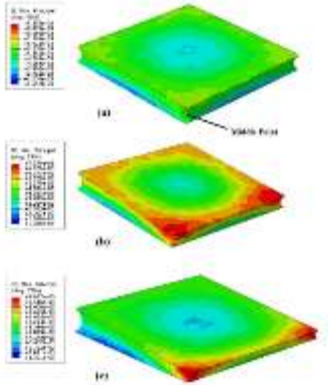
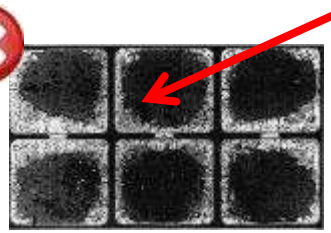


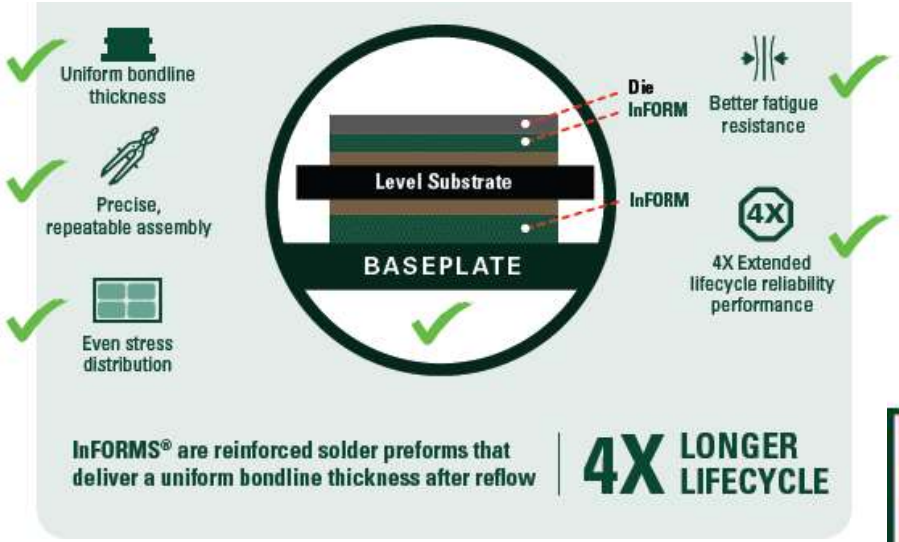
Figure 5. Max. principal IE of solder with different die tilt displacements. (a) Without tilt. (b) U_y=20μm. (c) U_y=50μm

Delamination over time



InFORMS® Reliability-Enhancing Solder Preforms

InFORMS® Solution

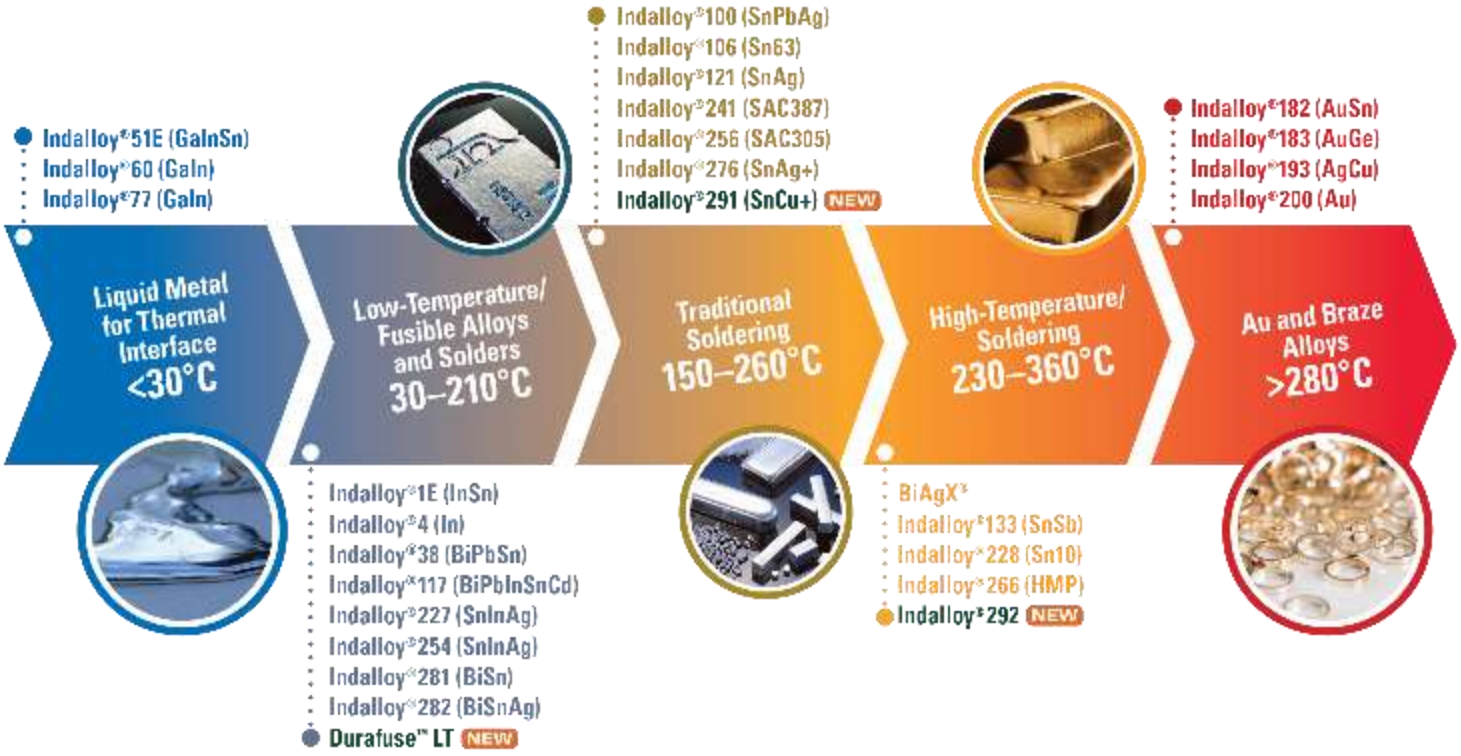


InFORMS® was developed to realize superior solder joint reliability in power module applications:

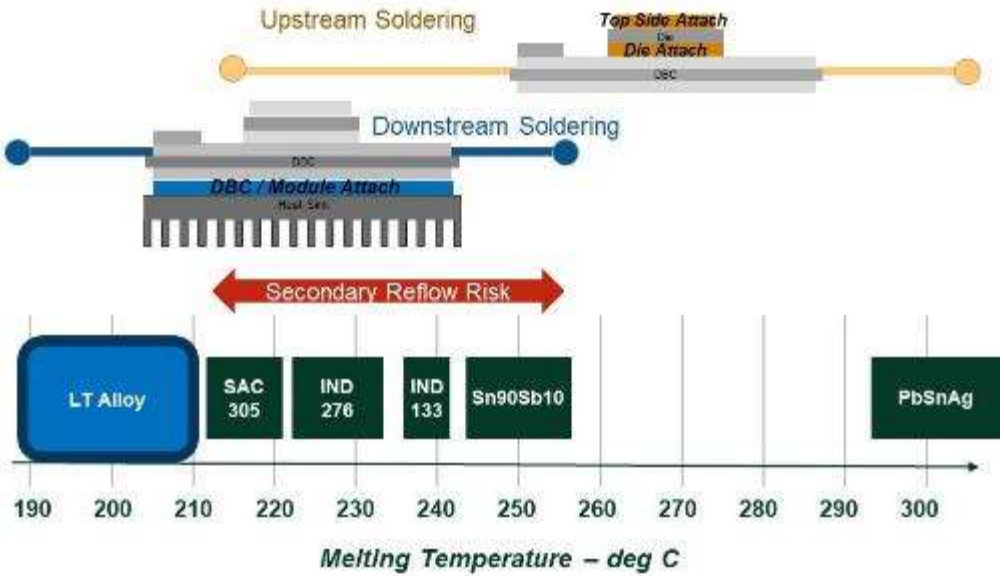
Standoff coverage across the entire assembly	→ Prevent tilt and stress concentration
Integrated matrix adds strength	→ Solder creep resistance
Precise, repeatable bondline thickness	→ Consistent soldering performance during production
Wide range of alloys and configurations available	→ Drop-in replacement for solder preforms

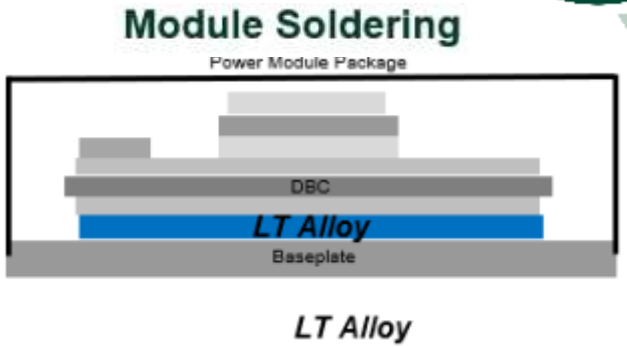
Delamination Mitigated

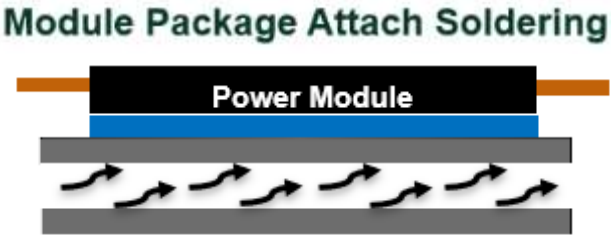
Solder Alloys for Power Electronics



Solder Alloys for Power Electronics







Emerging LT Alloy Technology offers lower processing temperatures while balancing reliability

QuickSinter® Sintering Materials

InFORCE™
Pressure Sinter Pastes

InFORCE™ MF AVAILABLE

Pressure silver sinter paste for die-attach

Features:

- Formulated for printing application. Reduce overprint
- High metal load / low organic content. Fast dry times, less material loss
- Multi finish. Sinters to Ag, Au or bare Cu
- Suitable for Si IGBT, SiC MOSFET and GaN HEMT
- Shear strength >50MPa for 5x5 SiC MOSFET

QuickSinter® 2.0
High metal content paste, redefining sinter technology for power electronics

Pressure sinter pastes for die and package attach applications

InFORCE™ 29 AVAILABLE

Pressure copper sinter paste

Features:

- Workability—printable or dispensable
- Sinters to Cu, Ag and Au
- Sinterable under N_2, vacuum, H_2, forming gas or formic acid
- Shear strength >40MPa
- High metal load / low organic content

InFORCE™ LA IN DEVELOPMENT

Pressure silver sinter paste for large area sintering/package attach

Features:

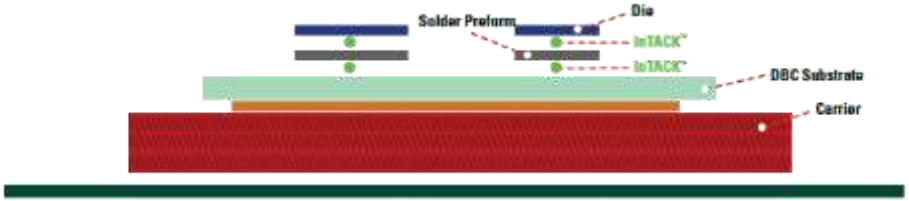
- Formulated for large areas such as sintered package attach
- Drying can be done after component placement (wet process)
- Dispense "print like" film deposits (slot nozzle dispensing)

InTACK™ for Power Modules

THE SOLUTION:

InTACK™ Technology

✓ Tacking material maintains alignment during assembly and reflow



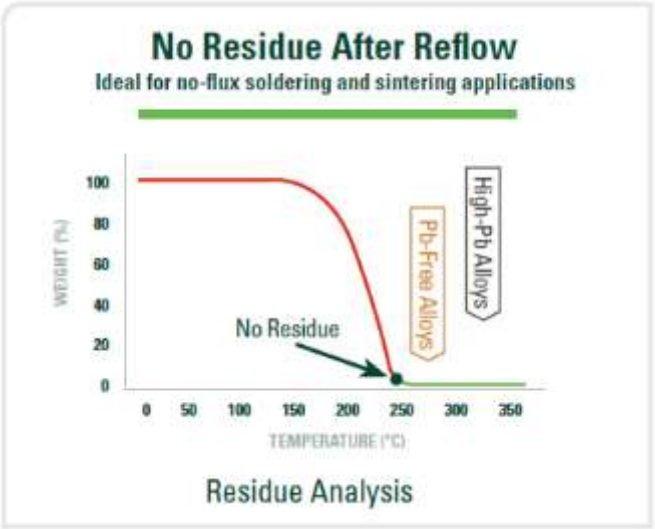
✓ No Tooling/ Fixturing Required

✓ Simplified Reflow Process

✓ Reduced Reflow Time

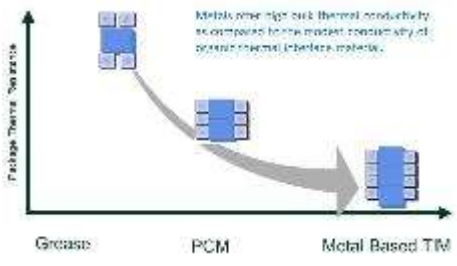
✓ Reduced Overall Process Time

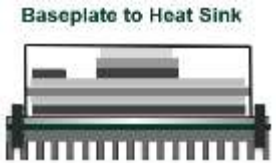
Dispense InTACK™ → P&P Preform → P&P Die → Transport → Reflow Process → Transport

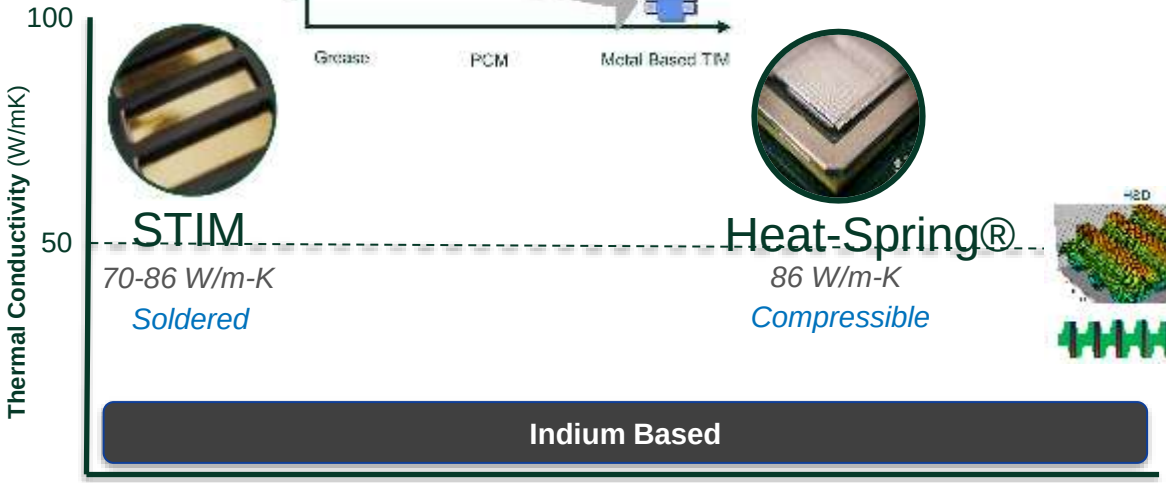


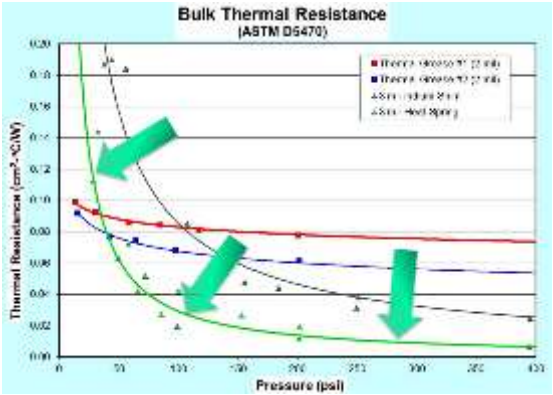
InTACK™ technology is specifically designed to achieve high-quality solder performance with no residue in flux-free reflow techniques commonly used in power module assembly

Thermal Interface Materials (TIMs)









Indium Corporation's expertise in metal-based TIM technology presents an opportunity to address power module requirements with increased packaging efficiencies and higher junction temperatures

Summary

85+ years of consistent growth

15 facilities globally

Indium offers a portfolio of products to address the performance demands for emerging power module designs:

- ✓Increased power densities, junction temperatures, reliability
- ✓Solder alloy innovations
- ✓InFORMS® for increased reliability
- ✓Sintering
- ✓Reduced assembly complexity
- ✓Thermal management

Thank you!

www.indium.com askus@indium.com

Contact Information:
Joe Hertline, Product Manager
Indium Corporation
jhertline@indium.com