
SEVENTEENTH ANNUAL
BiTS
Burn-in & Test Strategies Workshop
March 6 - 9, 2016
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive- Session 2
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BiTS 2016 Burn-in & Test Strategies Workshop

Session 2
Ashok Kabadi
Session Chair

BiTS Workshop 2016 Schedule

Frontiers Day

Monday March 7 - 1:30 pm

Material Matters

"Long Life Probe Pin by Electroforming Process"
Makota Kondo & Hirotada Teranishi - Omron Corporation
Takahiro Sakai & Naoyuki Kimura - Omron Corporation

"Carbon Nanotube Polymer Composites as High Performance Thermal Interface Materials for Burn in and Test Applications"
Leonardo Prinzi - Georgia Institute of Technology
Craig Green & Baratunde Cola - Carbice Nanotechnologies, Inc.

"Requirements and Solutions for Test PCBs"
Markku Jamsa - Aspocomp Group Oyj

"PCB Test Fixture and Socket Challenges for mmWave Applications"
Don Thompson Jose - R&D Altanova
Jose Moreira - Advantest Europe GmbH
Giovanni Bianchi - Advantest

Carbon Nanotube Polymer Composites as High Performance Thermal Interface Materials for Burn in and Test Applications

Craig Green[1], Leonardo Prinzi[2], Baratunde Cola[1]
[1]Carbice Nanotechnologies; [2]Georgia Tech

2016 BiTS Workshop
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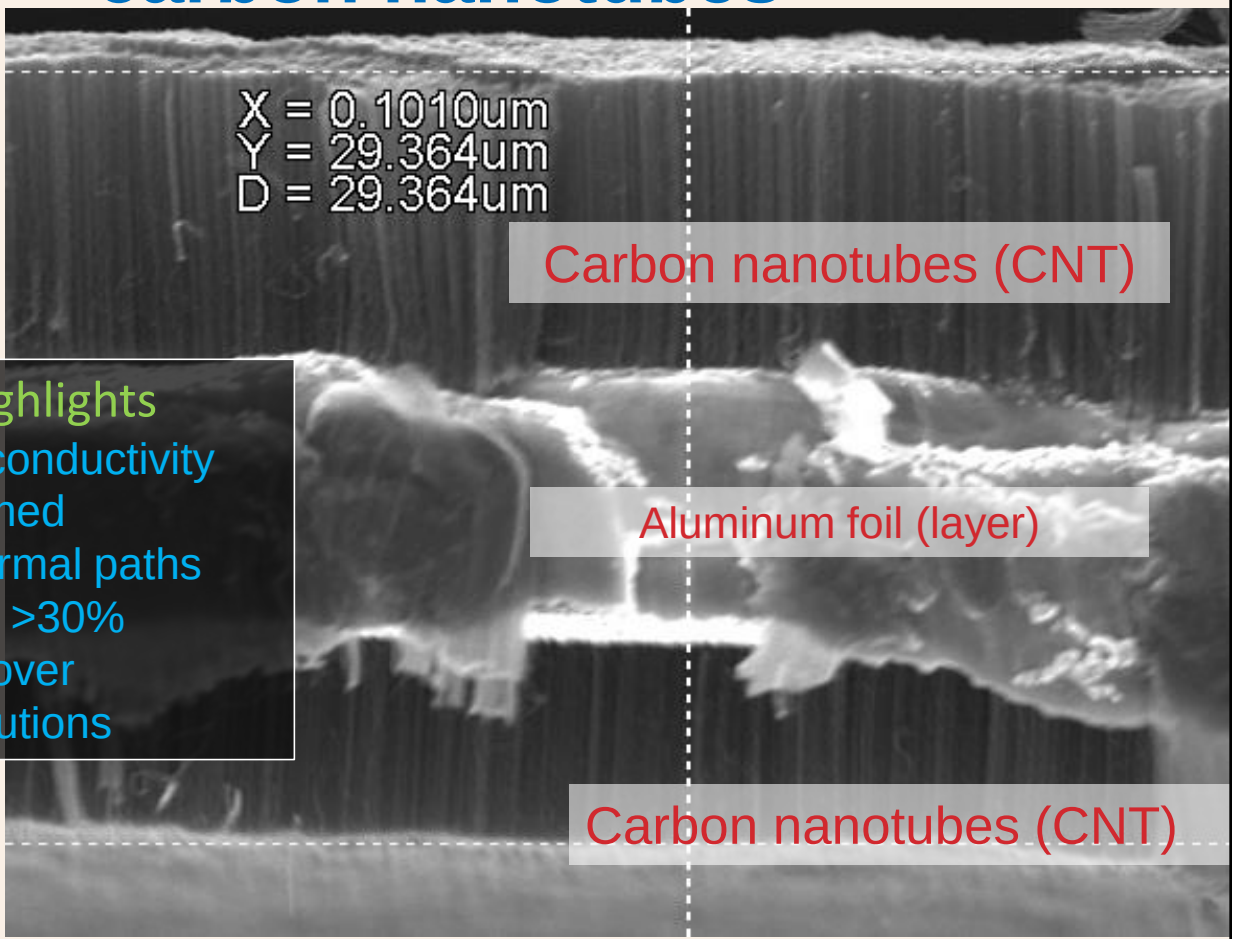
Carbon Nanotube Polymer Composites as High Performance Thermal Interface Materials for Burn in and Test Applications

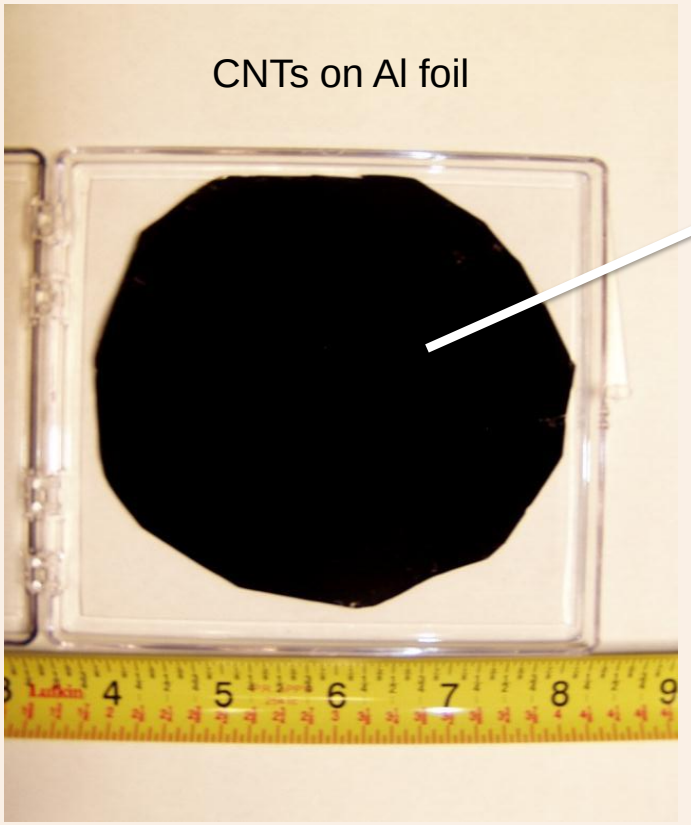
Technology overview: vertically aligned carbon nanotubes

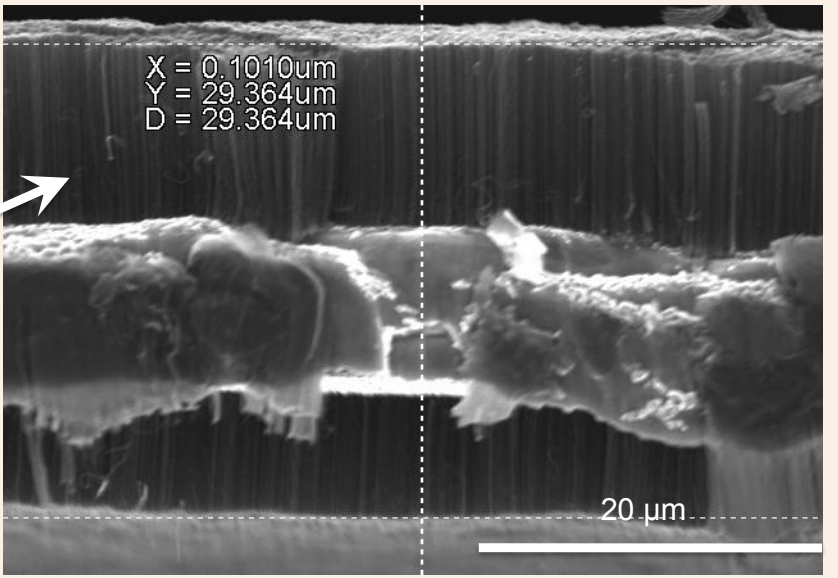


Technology - Highlights

- High thermal conductivity
- Billions of aligned nanoscale thermal paths
- Demonstrated >30% improvement over alternative solutions

Carbice CNT growth technique ready to scale



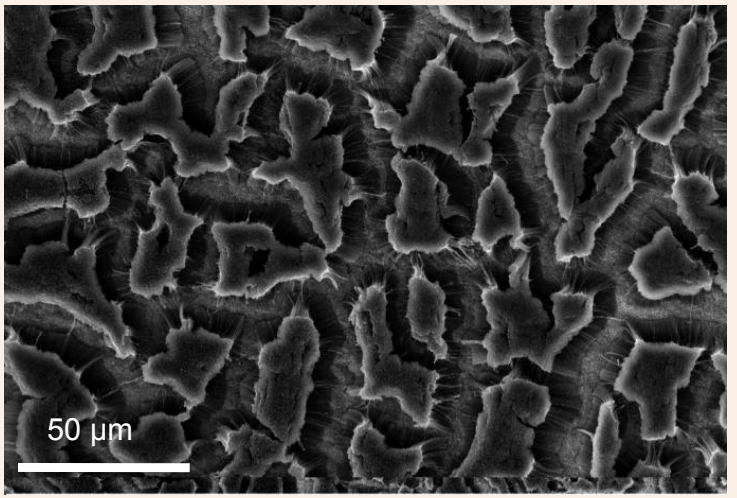


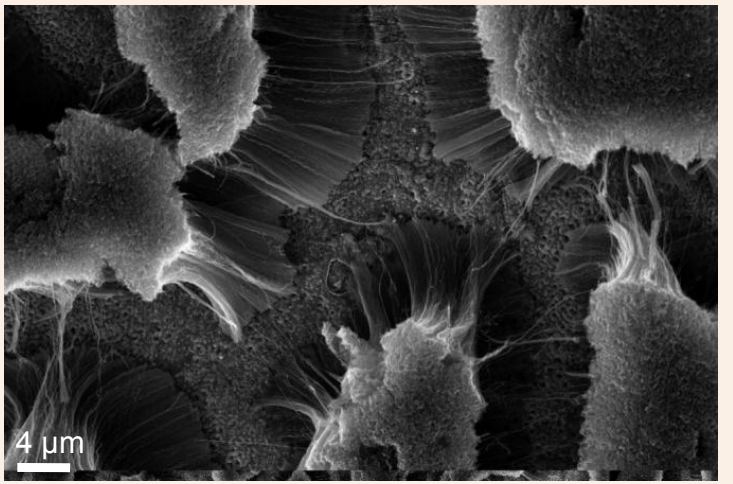
Scalable process with > 95% yield

Patent No. US2013/049900

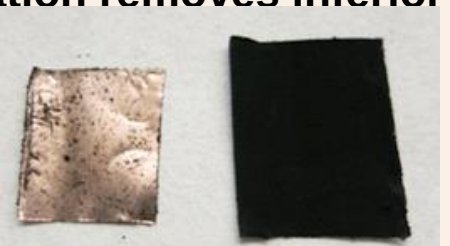
Robust CNT anchoring process

After 5 min sonication in ethanol – Carbice CNTs remain intact





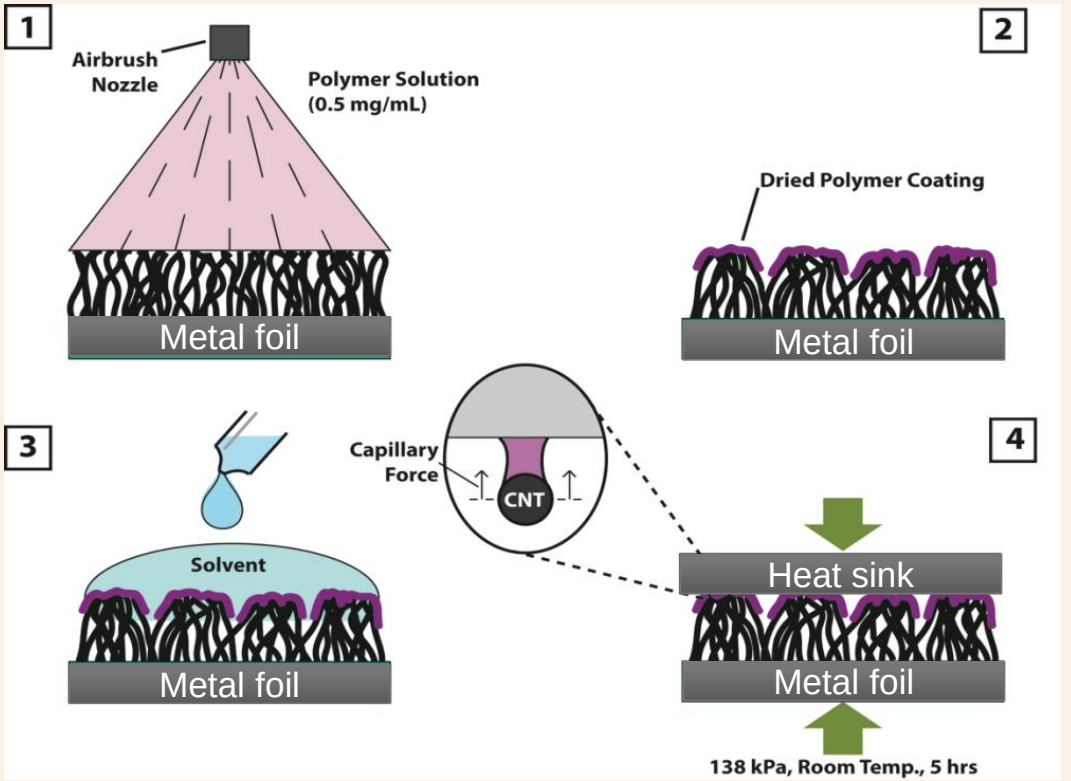
Sonication removes inferior CNT



Inferior CNTs After Sonication

Patent No. US2013/049900

CNT bonding process

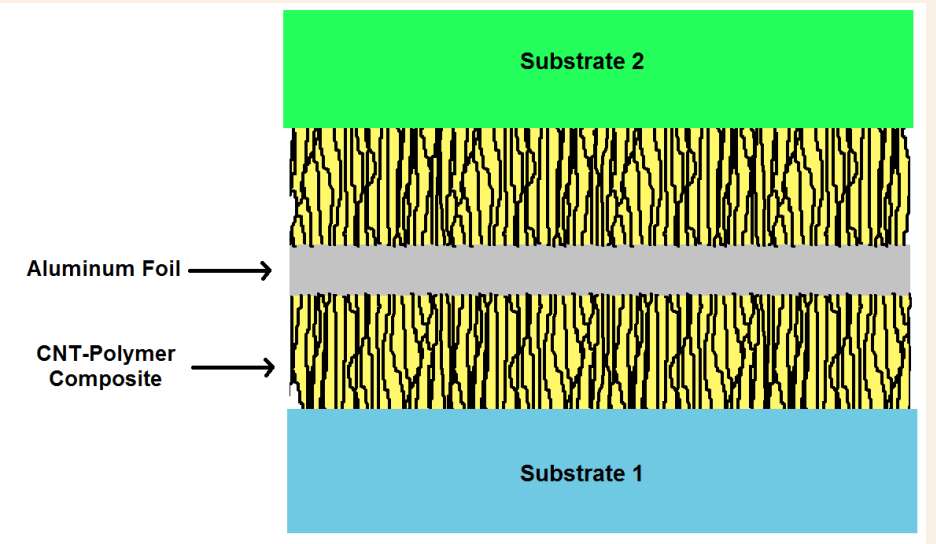


Lowers thermal resistance by **70%**

J.H. Taphouse et al., *Nanotechnology*, **24**:105401, 2013

Patent No. WO 2013044094 A8

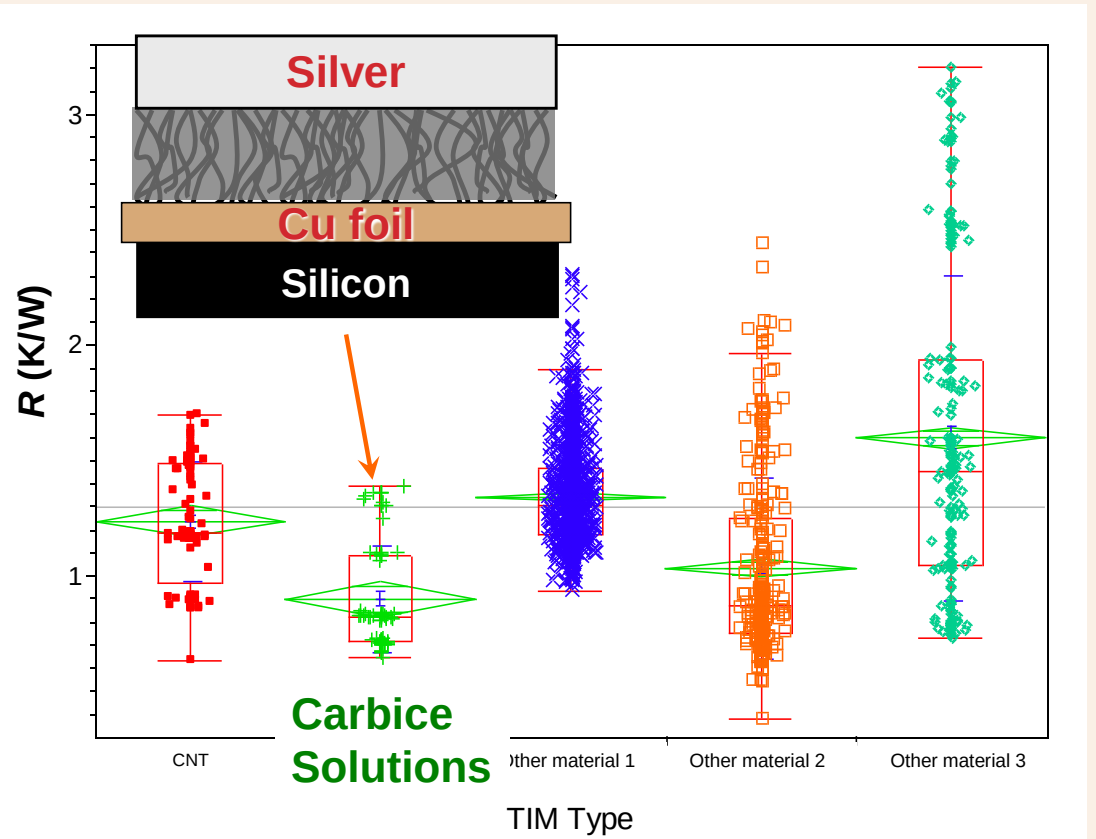
CNT-polymer composites: design strategy



Polymer selection and application tailors mechanical and thermal properties to specific applications

- Mechanical resilience and compliance
- Reduces thermal resistance
- Safe handling and CNT encapsulation

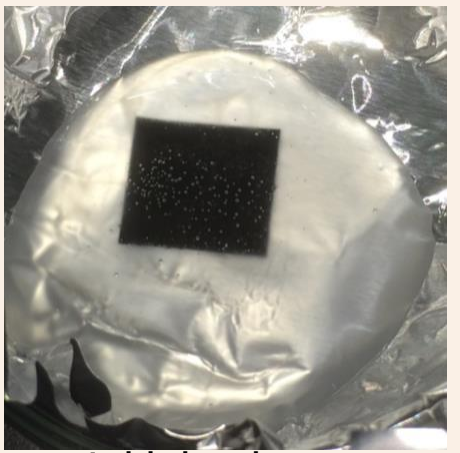
Faster, reliable, lower cost tests with Carbice



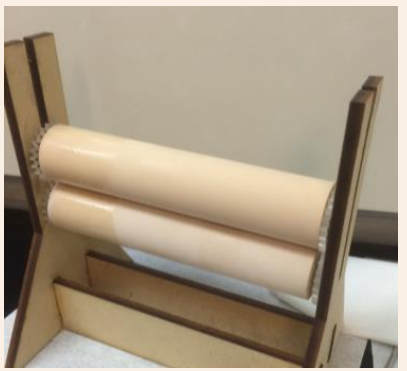
Carbice out performs baseline by more than 30%

Polymer infiltration process

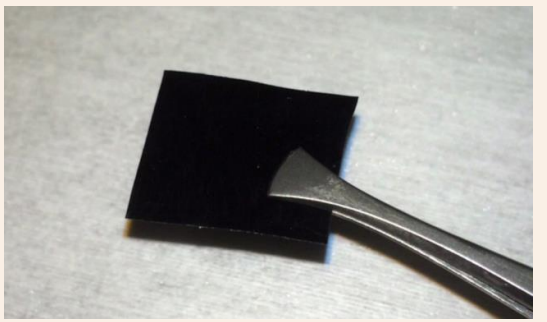
Carbice proprietary polymer solution



Initial polymer infiltration

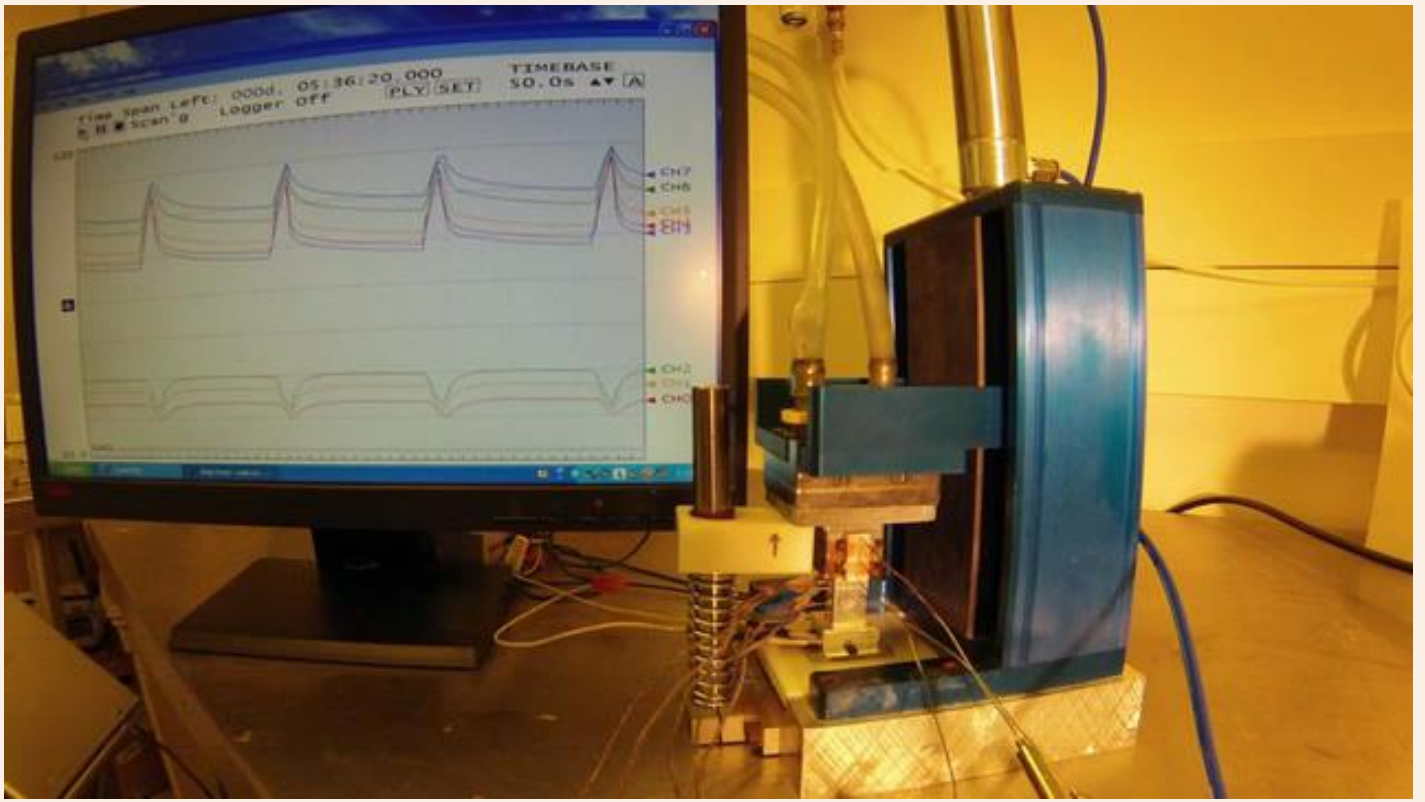


Removal of excess polymer



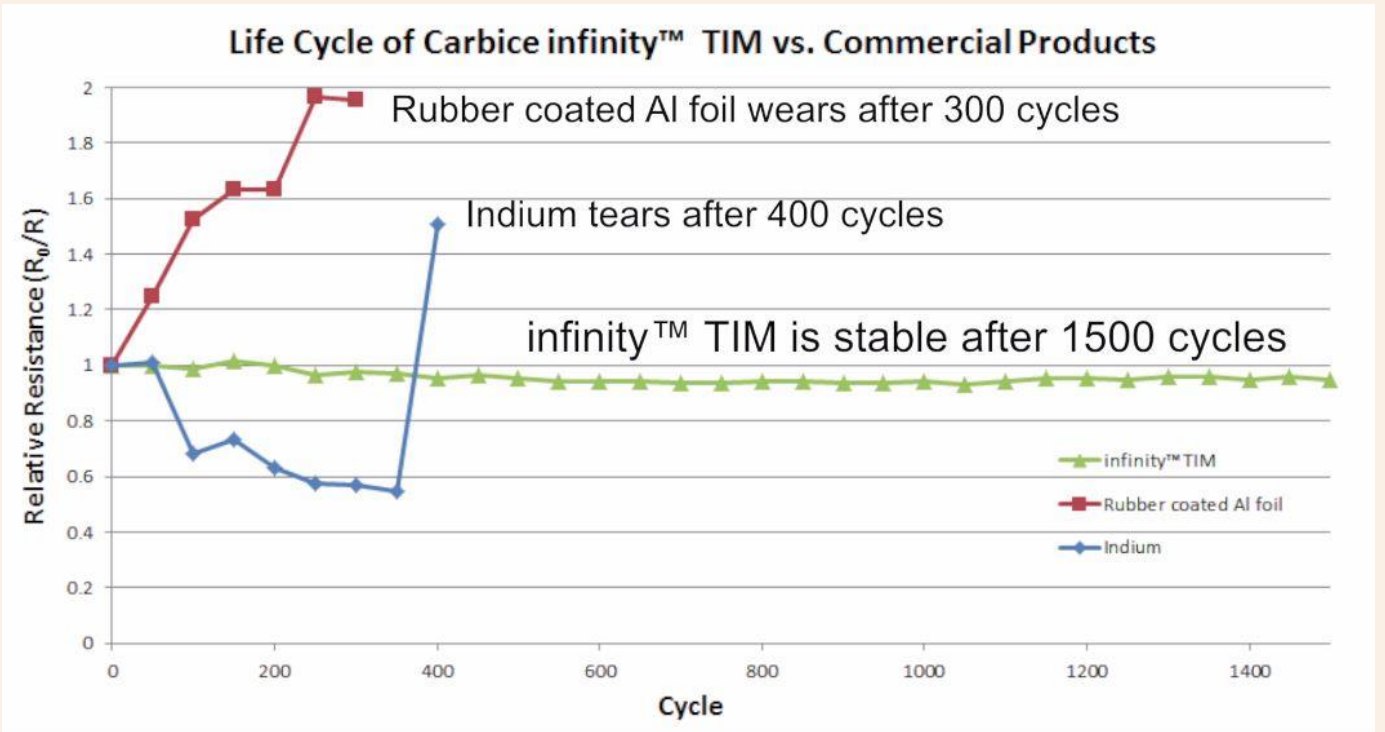
infinity™ TIM

Carbice infinity™ TIM … product testing



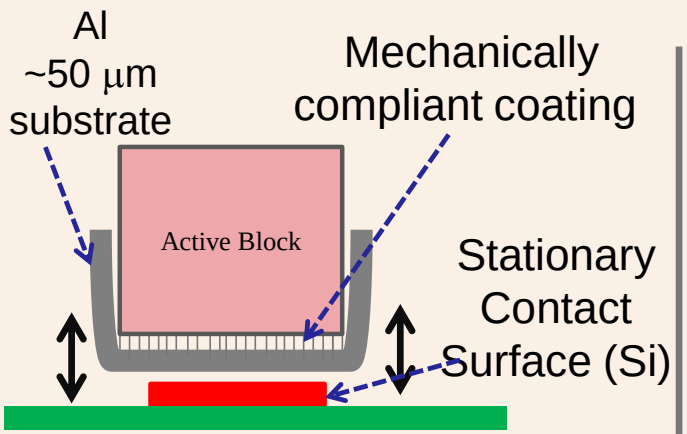
Bench top burn in system demonstration

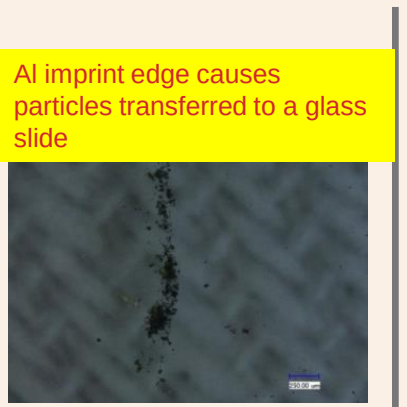
Lifecycle performance data

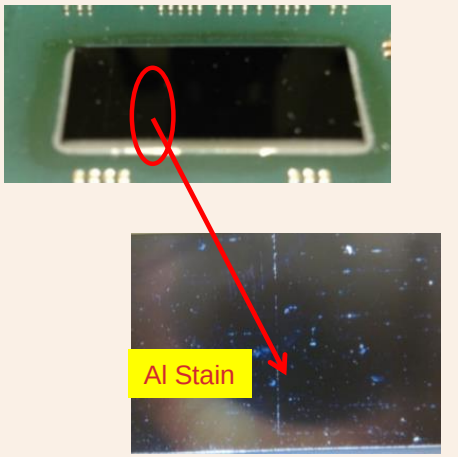


- Common Burn In TIMs wear after a few hundred cycles
- infinity™ TIM is still robust after 1500 cycles

Die staining: Debris



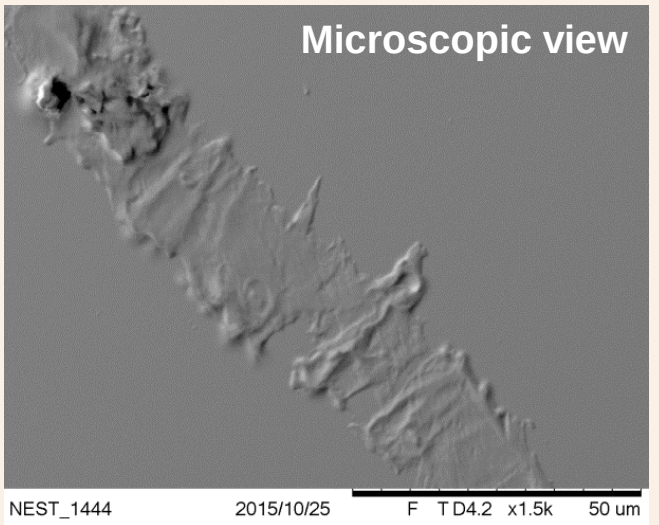


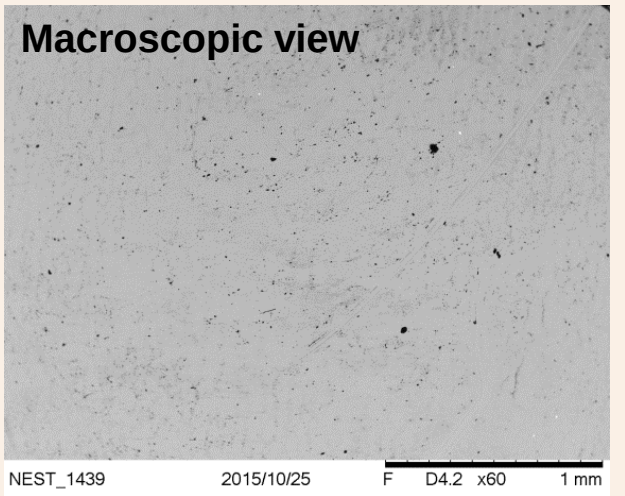


- Current TIMs are wrapped in Al foil to protect from residue transfer
- After 100's-1000's of cycles Al wears and causes staining
- infinity™ TIM doesn't stain under similar test

Die staining: Polymer residue

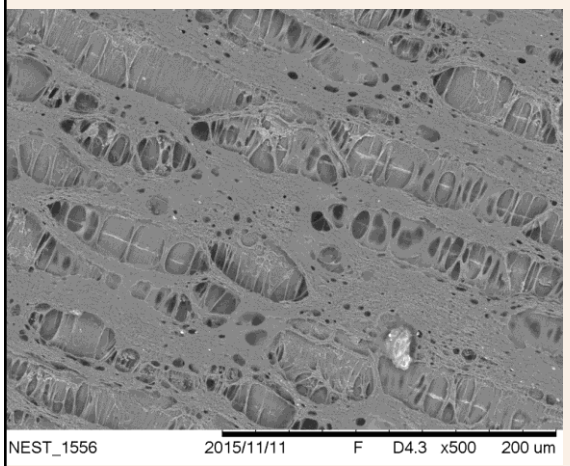
SEM images of Si die after polymer staining



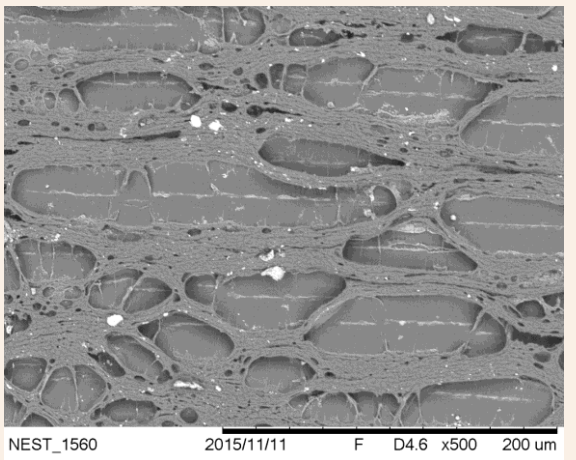


- In addition to debris transfer, polymers can leach or decompose at high temperatures, leading to staining
- 12 hr. pressurized bake at 120 °C conducted to induce polymer driven die staining

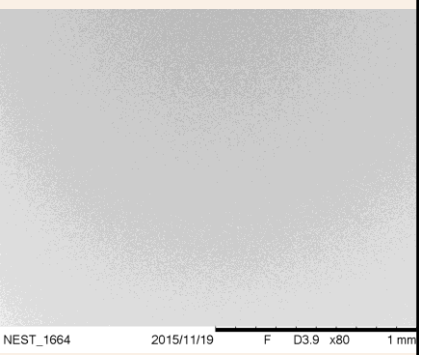
Stain free polymer coating



TIM with poor polymer coating



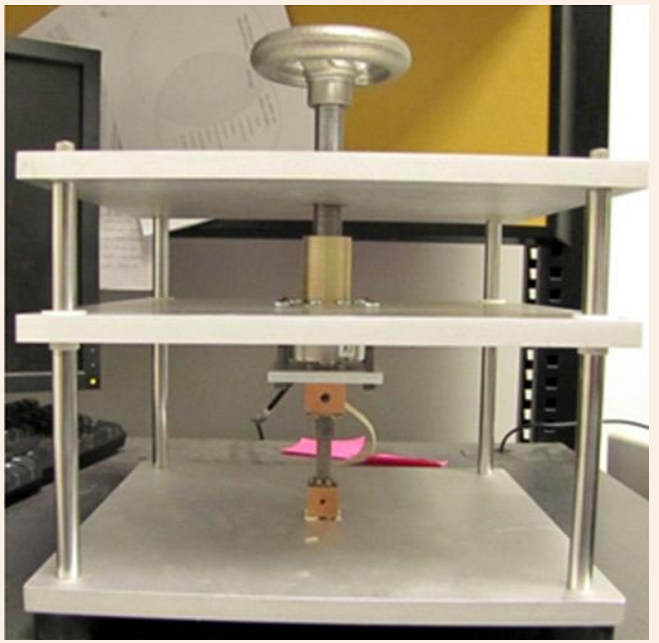
Post processed infinity™ TIM

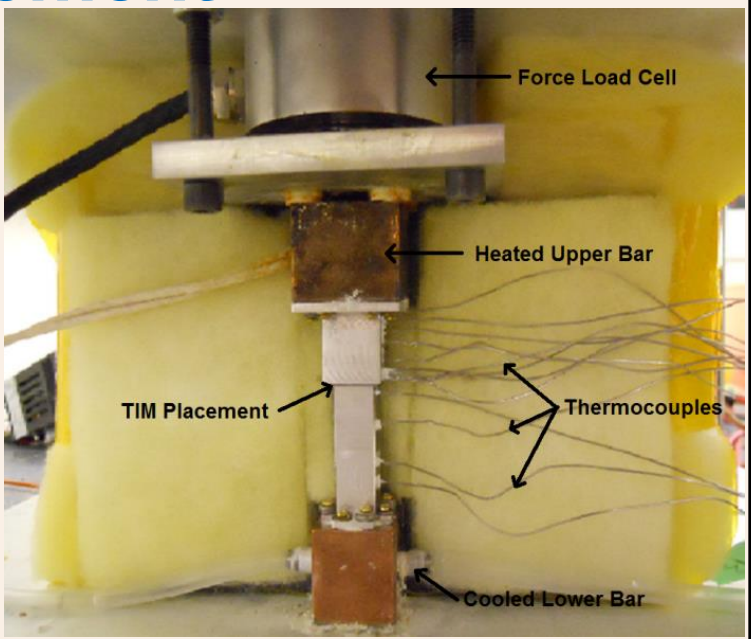


Stain Free Die

- Improved polymer identified
- Solvent washing process developed to remove excess polymer
- Stain free performance achieved

Steady-state thermal resistance measurement

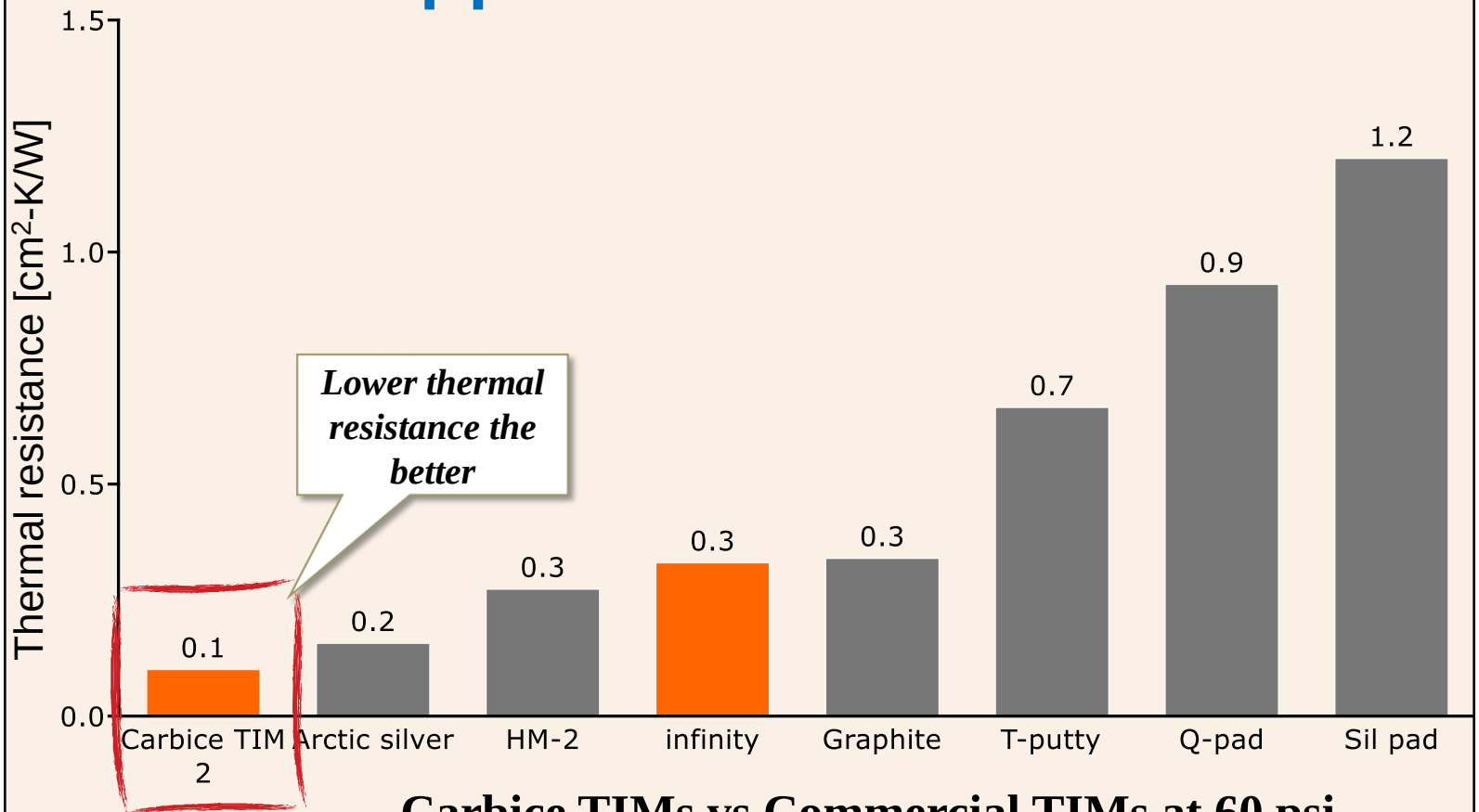




- Modified ASTM-5470 stepped bar apparatus
- Low cost but precise means of measuring thermal resistance

D.R. Thompson et al. A Stepped-Bar Apparatus for Thermal Resistance Measurements. ASME JEP, 2013.

Thermal Properties Tunable to Application Demands



Carbice TIMs vs Commercial TIMs at 60 psi

Carbon Nanotube Polymer Composites as High Performance Thermal Interface Materials for Burn in and Test Applications

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Summary of Carbice enabled functionality

Thermal Interface Material Product Comparison Chart

	Carbice	Arctic Silver 5	Bergquist Gap Pad	Graphite	Indium Foil	ShinEtsu X23	Thermagon Tputty 502
Low thermal resistance [< 30 mm^2K/W]	✓	✓	✗	✗	✓	✓	✗
Thermal stability at elevated temp [> 200 ^oC]	✓	✗	✗	✓	✗	✗	✗
Mechanical Compliance [“Shape memory” over 1000 cycles]	✓	✗	✓	✗	✗	✗	✓
Ease of rework [Removable w/o aid of chemicals]	✓	✗	✓	✓	✗	✗	✓