

NINETEENTH ANNUAL

BiTS

BiTS™

Burn-in & Test Strategies Workshop

March 4 - 7, 2018

**Hilton Phoenix / Mesa Hotel
Mesa, Arizona**

Archive

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www.bitsworkshop.org

New Possibilities in Composite Materials and How to Simulate Them

Mike Gedeon
Materion

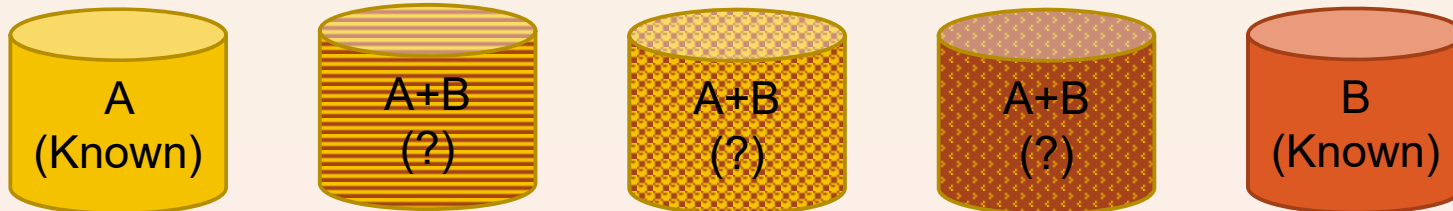


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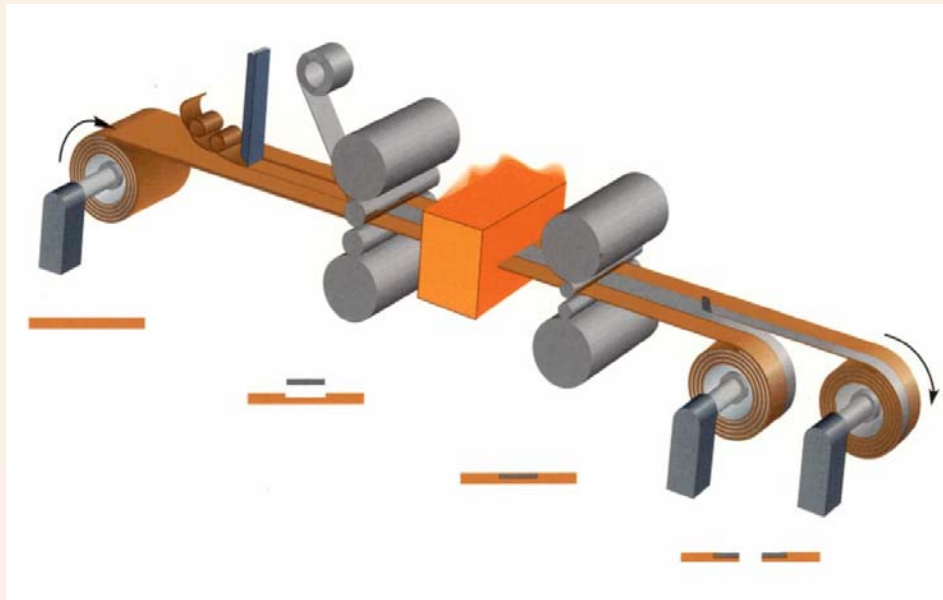


Definitions

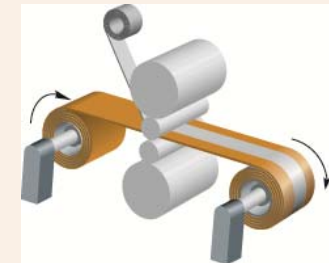
- Monolithic – Consisting of one material or alloy
- Composite – Consisting of more than one separate material



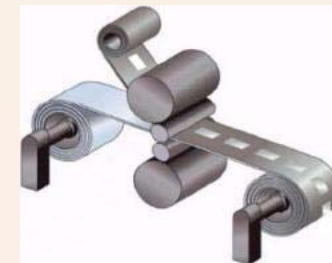
Clad Composite



Overlay



Inlay



Patterned

Some History of Clad Metals Combining High Strength and High Conductivity

- 1962 – Texas Instruments Conflex Material
 - Cu over 1065 stainless steel
 - Made by many today

COPPER CLAD AUSTENITIC STAINLESS STEEL—A HIGH STRENGTH HIGH CONDUCTIVITY MATERIAL FOR CONNECTOR APPLICATIONS

James Forster
Texas Instruments Incorporated
34 Street
Attleboro, MA 02703



Using Clad Alloys to Make High Temperature Burn-in and Test Sockets

Terry Morinari
Enplas Semiconductor Peripheral Corp.
1-19-57 Kamiaaki
Kawaguchi City, Saitama Pref. 333-0844, Japan
t-morinari@enplas.com

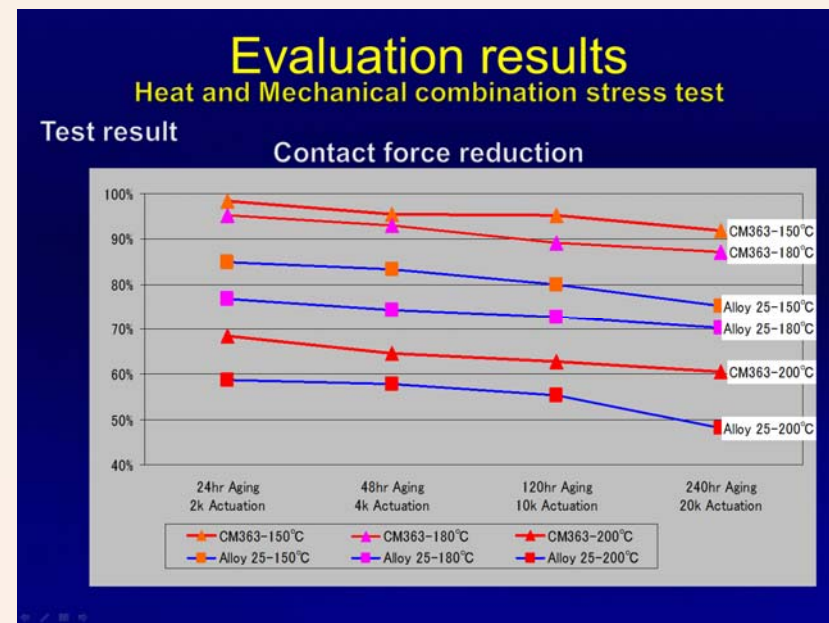
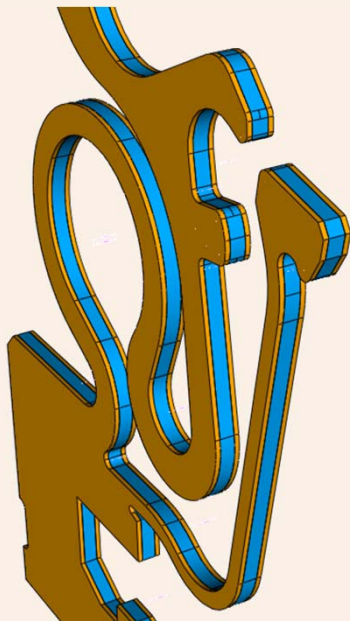
Jimmy Johnson
Materion Brush Performance Alloys
6070 Parkland Boulevard, Mayfield Heights, OH 44124, USA
jimmy.johnson@materion.com



2012 BiTS Workshop
March 4-7, 2012

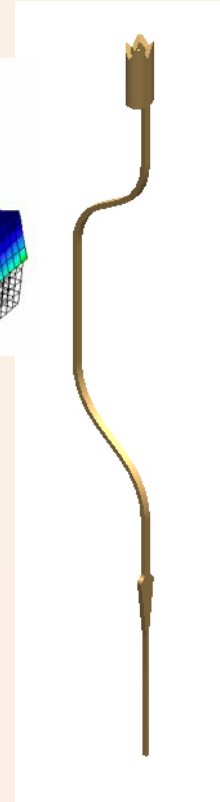
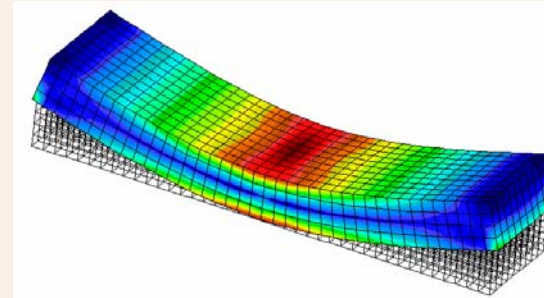


2012 BiTS Workshop



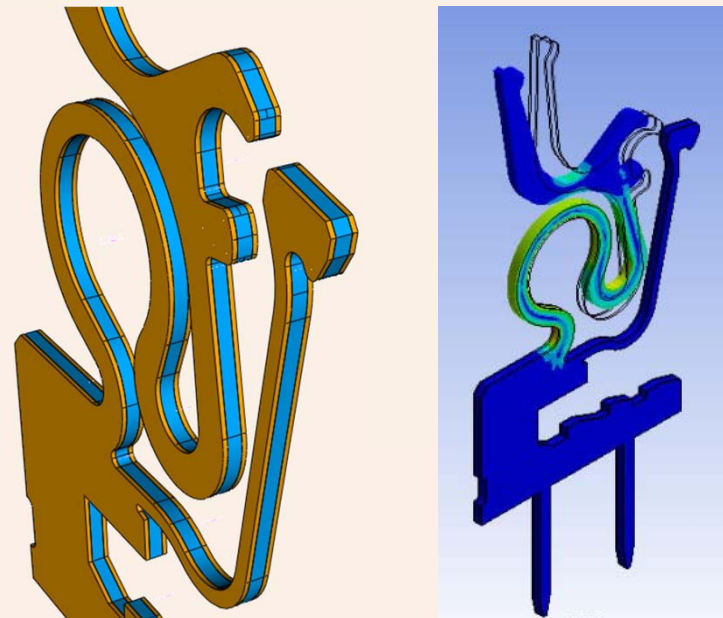
Stress Distribution in Bending

- Outer Surface Stress
 - Highest in the whole structure
 - Dominates fatigue life (# of cycles)
 - Dominates stress relaxation resistance (high temperature capability)
- Center of Beam
 - No to low stress
- Put high strength material on outside and high conductivity material on inside



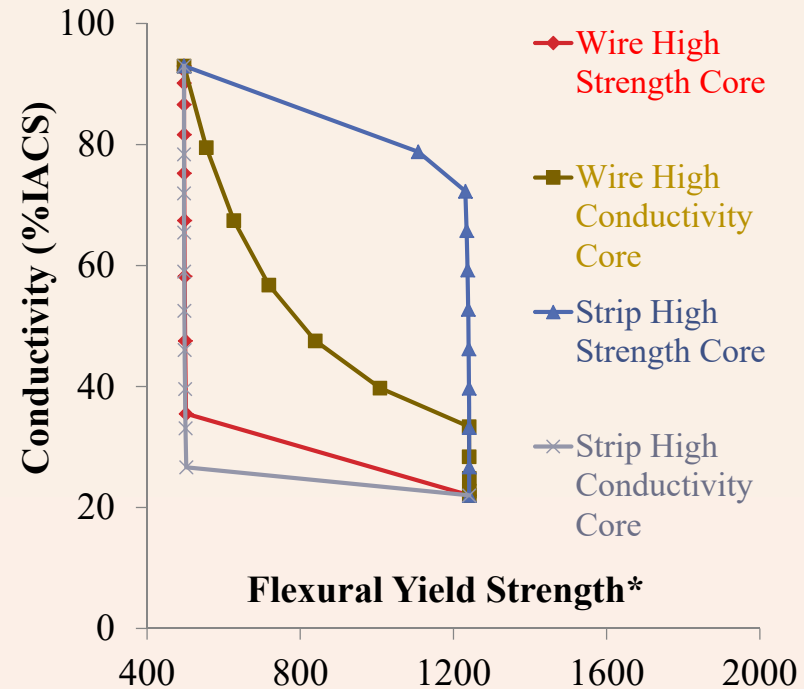
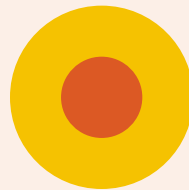
In-Plane Loading (No Out of Plane Bending)

- Either configuration works

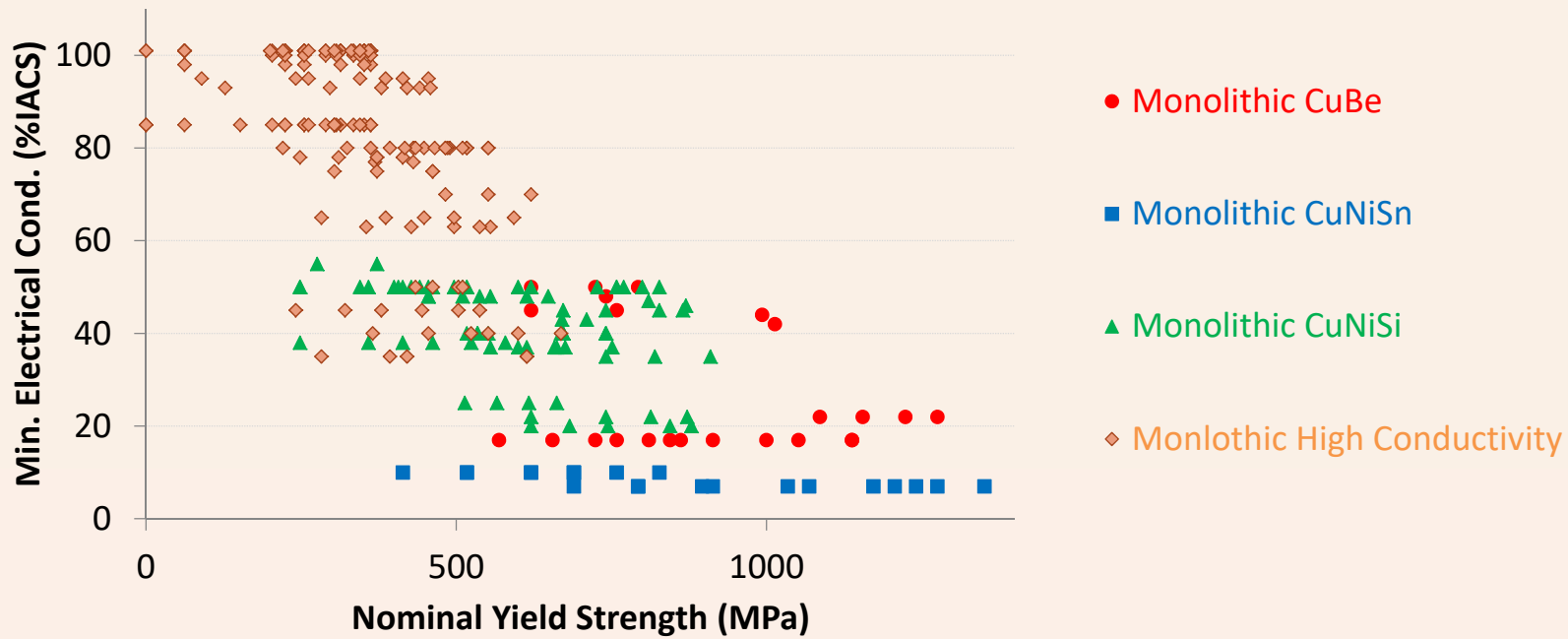


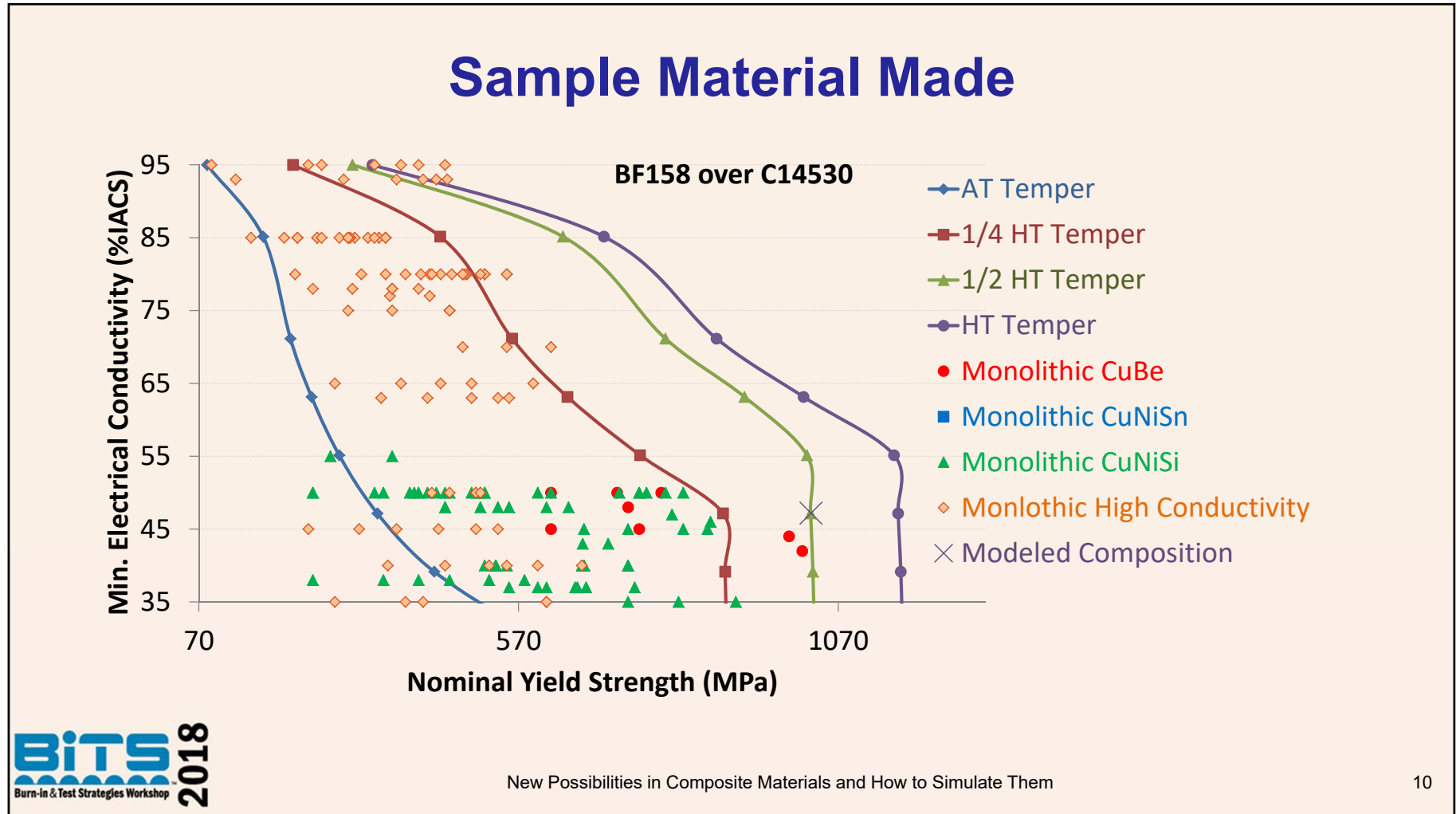
Composite Strength

- In Tension – Soft Metal Dominates
- In Bending – Outer Metal Dominates
- Round Cross Sections Less Effect than Rectangular



Commercially Available Copper Alloys





Simulation Tip

- Modelling Complicated composite materials
 - Separate the physics where possible
 - Start simple (fewest properties)
gradually complicate (most properties)
 - Design simple physical test rig
 - Model as homogenous solid
 - Parametrize properties until simulation matches physical test
 - Combine results for future simulations

Where Else Can I Use this Strategy?

- Find effective stiffness, conductivity, internal inductance & capacitance as function of strain

BiTS 2016
Session 7 Presentation 1
Very Touching - Contact Technology

Implementation of MEMS Particles Dramatically Improves Conventional Rubber Sockets

**Justin Yun,
Dave Oh, & Kang Hee Kim
TSE Co., Ltd.**

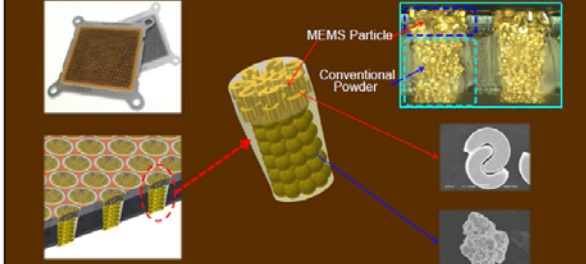
 2016 BiTS Workshop
March 6 - 9, 2016 


Burn-in & Test Strategies Workshop www.bitsworkshop.org March 6-9, 2016

BiTS 2016
Session 7 Presentation 1
Very Touching - Contact Technology

MRC Socket Background

- MRC Socket
- ✓ MEMS Particle + Conductive Powder



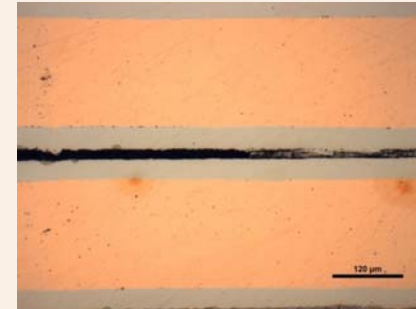
 2016 Implementation of MEMS Particles Dramatically Improves Conventional Rubber Sockets 3

Burn-in & Test Strategies Workshop www.bitsworkshop.org March 6-9, 2016

Theoretical Spreadsheet Calculations and FEA

- Configuration:

- Length: 10.0 mm, Width: 1.0 mm
- Thickness: 0.1 mm
 - 0.025 mm BF158 ½ HT top
 - 0.050 mm C14530 ½ H middle
 - 0.025 mm BF158 ½ HT bottom



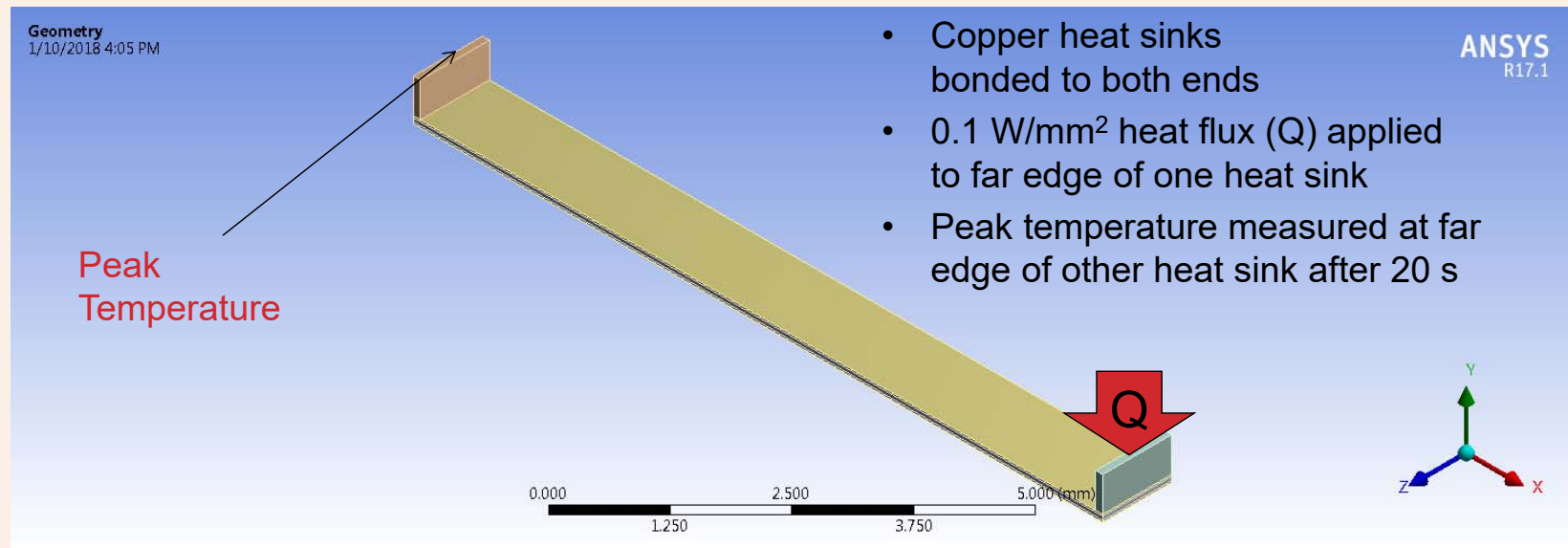
Alloy	Temper	Modulus	Thickness	I	E*I	Conductivity	0.2% OYS	MBR/t		CTE
		(GPa)	(mm)	(mm ⁴)	(MN mm ²)	(%IACS)	(MPa)	GW	BW	(ppm/°C)
BF 158	1/2 HT	127.6	0.025	0.0004	0.0465	7.8	1034	0.0	0.5	16.38
C14530	1/2 H	120.0	0.05	0.0001	0.0125	95	310	1.5	2.0	17.64
BF 158	1/2 HT	127.6	0.025	0.0004	0.0465	7.8	1034	0.0	0.5	16.38
		123.76	0.100	0.0008	126.60	47.2	1027	0.0	0.5	17.0
		Tensile Modulus (Gpa)		Flexural Modulus (GPa)		Conductivity (%IACS)	Flexural Yield Strength (MPa)	Formability		CTE

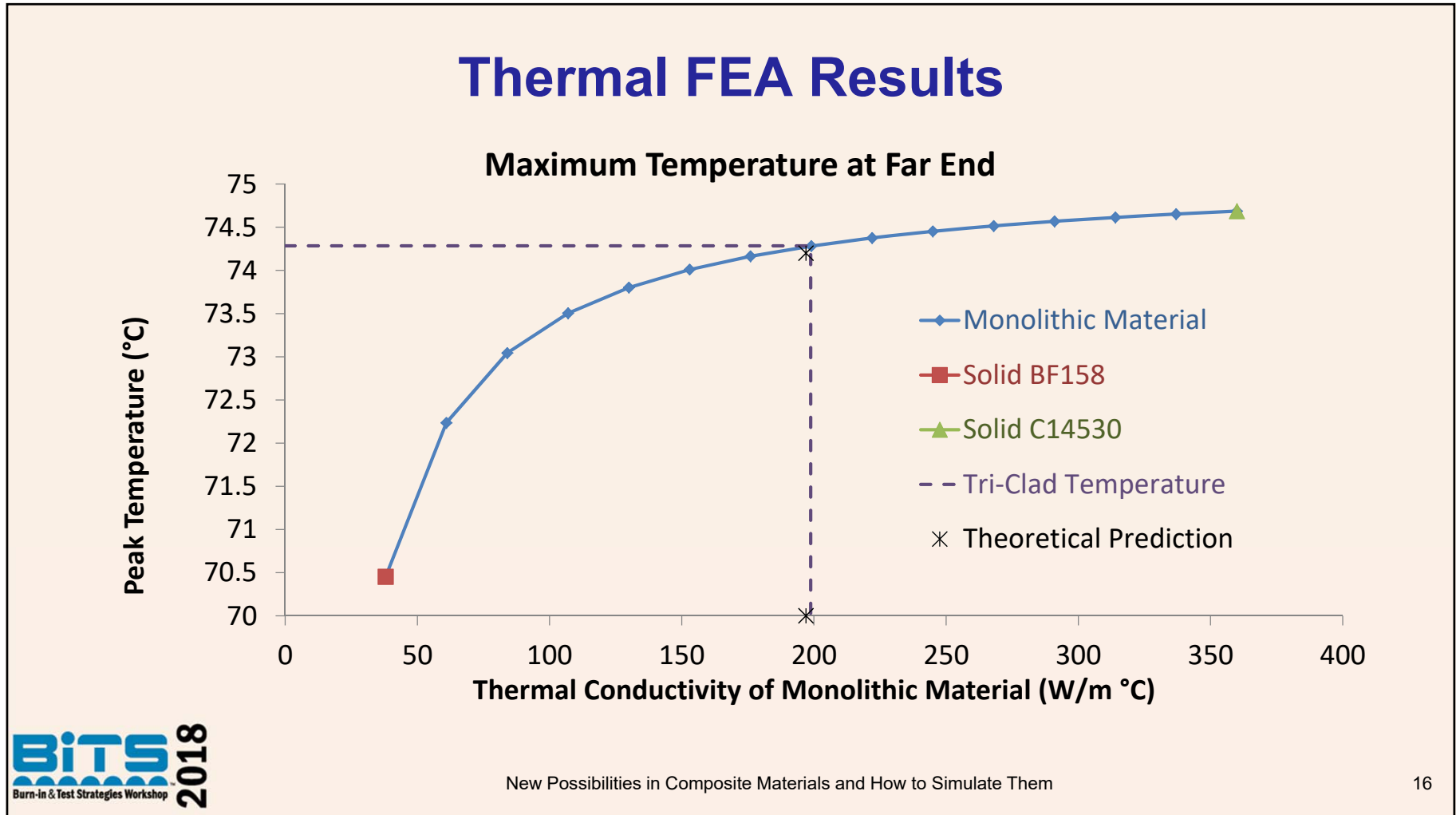


Thermoelectrical FEA Procedure

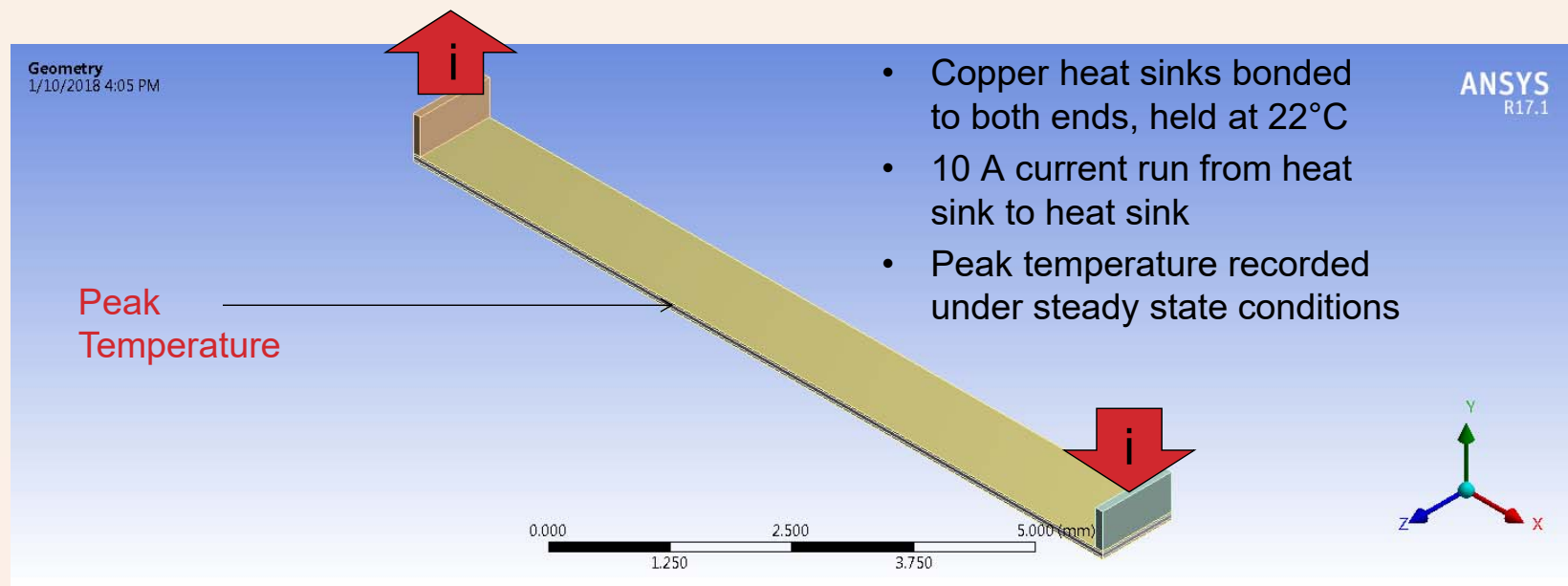
- Thermal Behavior
 - Model composite with heat transfer problem
 - Compare to monolithic material with varying k_x
- Electrical Behavior
 - Model composite with electrical heating problem
 - Compare to monolithic material with k_x determined above and varying σ

Thermal Finite Element Model



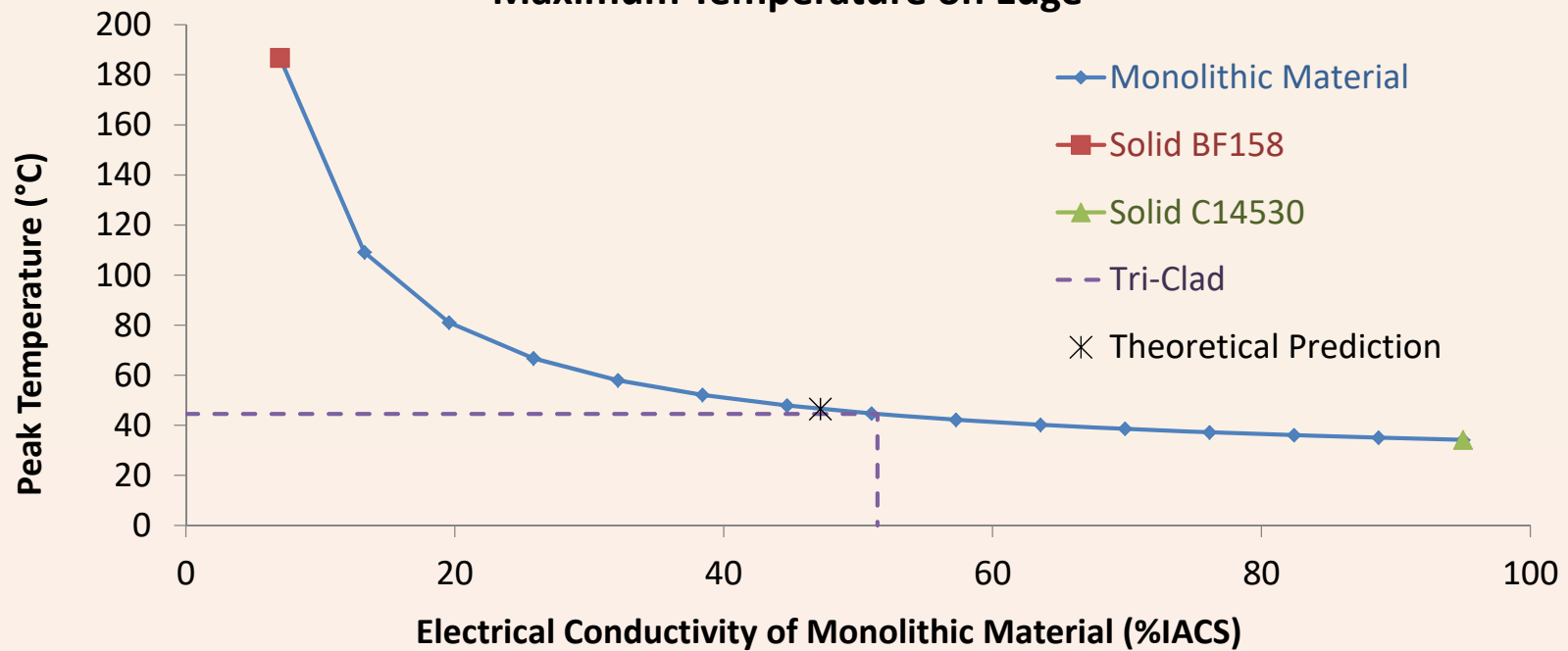


Thermo-electric Model



Thermo-electric FEA Results

Maximum Temperature on Edge



Thermoelectrical FEA Results

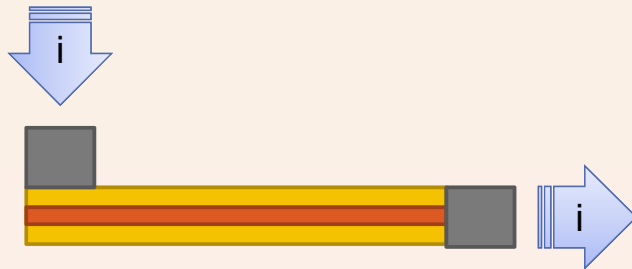
- 4 Possible Current/Thermal Paths



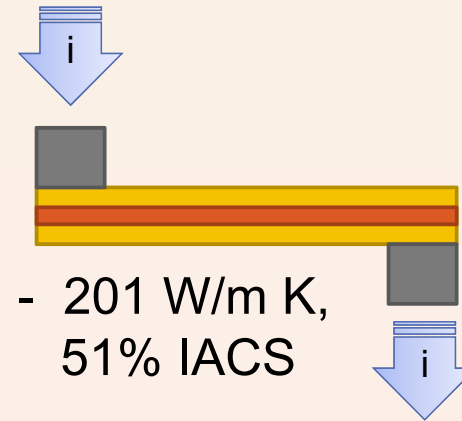
- 199 W/m K, 51% IACS



- 199 W/m K, 51% IACS



- 199 W/m K, 51 % IACS

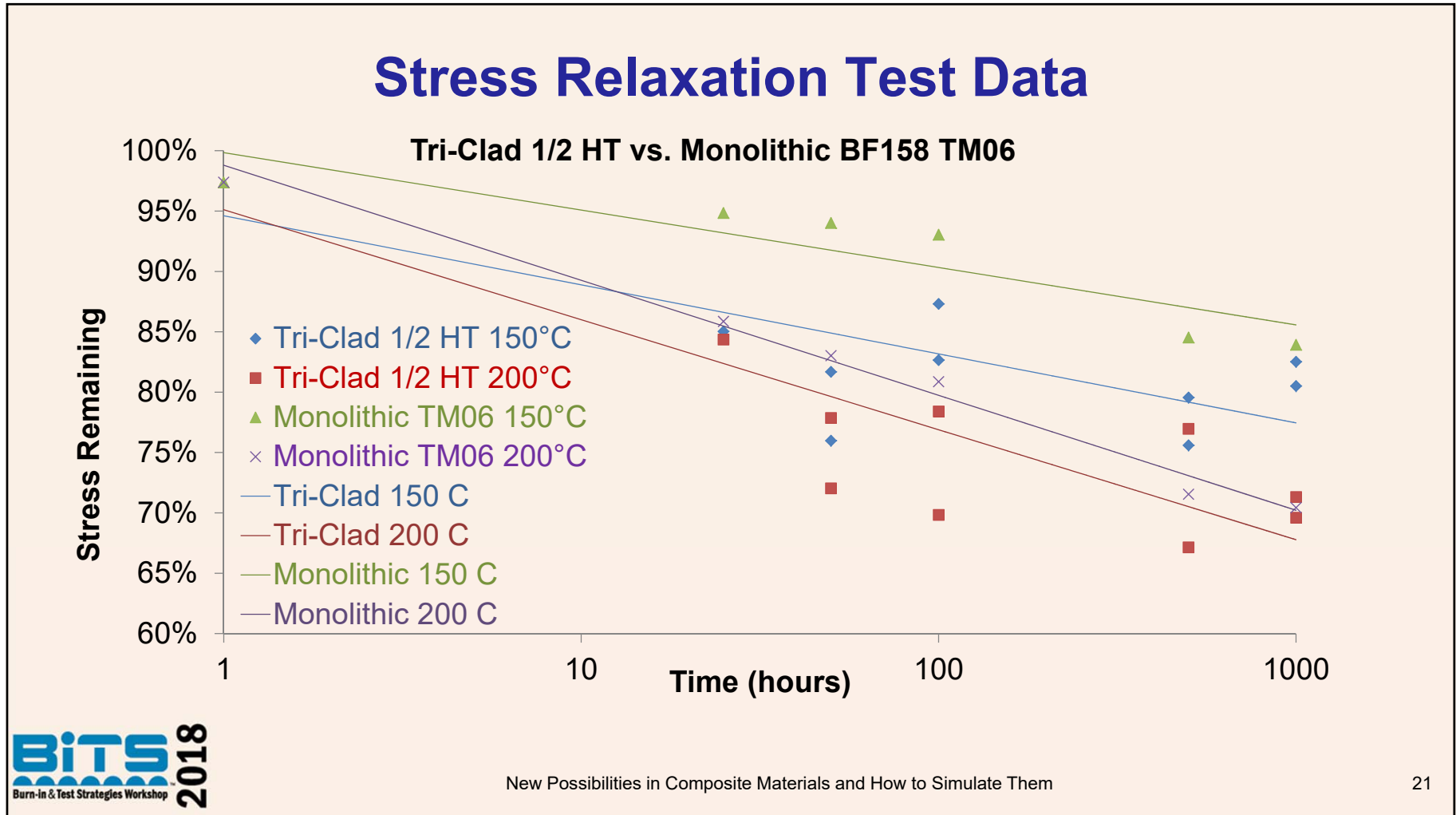


- 201 W/m K,
51% IACS

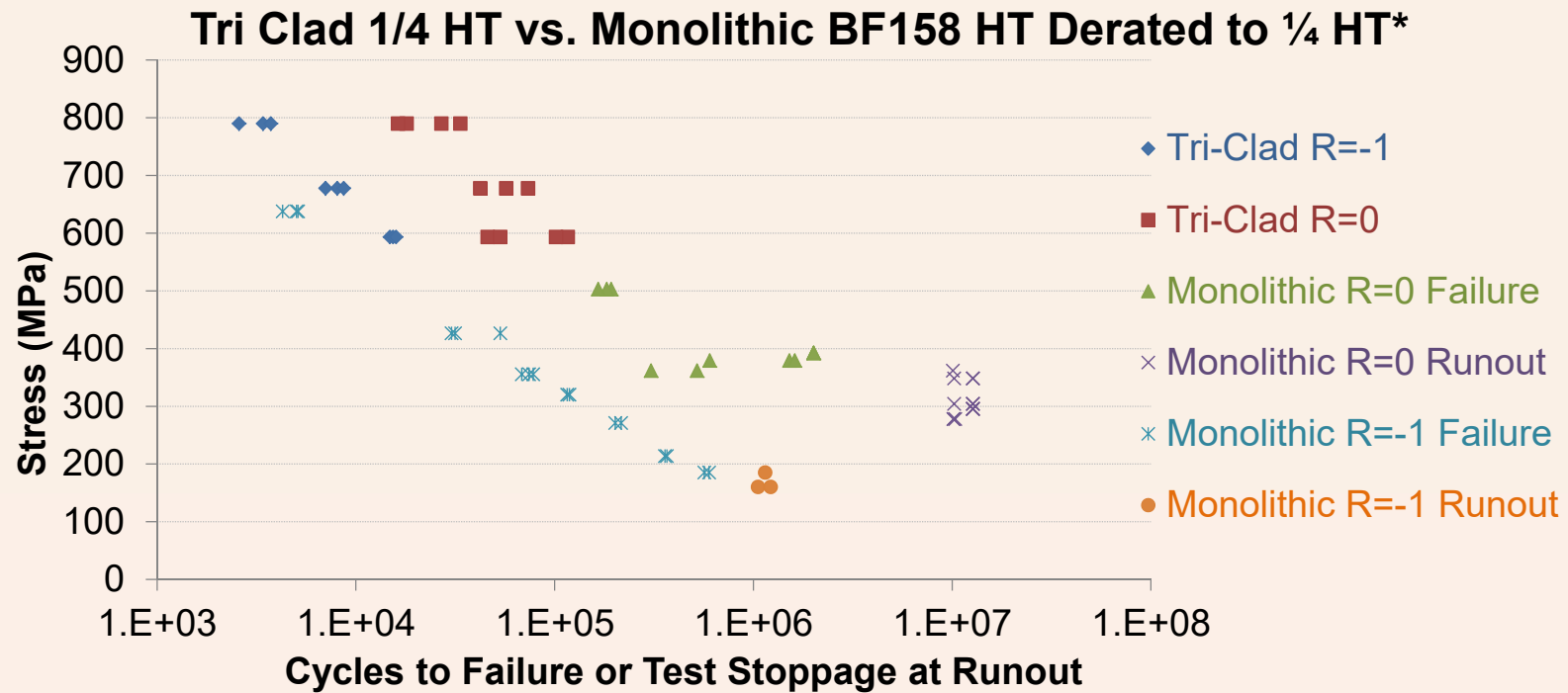
Discussion

- Fatigue and stress relaxation physical test results in line with theory
- Thermal and electrical conductivity converge to resistors in parallel under all configurations

	Thermal Conductivity	Electrical Conductivity	Flexural Modulus	Flexural Yield Strength	Thermal Expansion Coefficient
Theoretical Prediction	197 W/m °C	47.2% IACS	126.60 GPa	1027 MPa	17.0 $\mu\text{m}/\text{m } ^\circ\text{C}$
FEA Model	199 W/m °C	51% IACS	126.60 GPa	937 MPa	17.0 $\mu\text{m}/\text{m } ^\circ\text{C}$



Fatigue Test Data



Potential Downsides

Recyclability

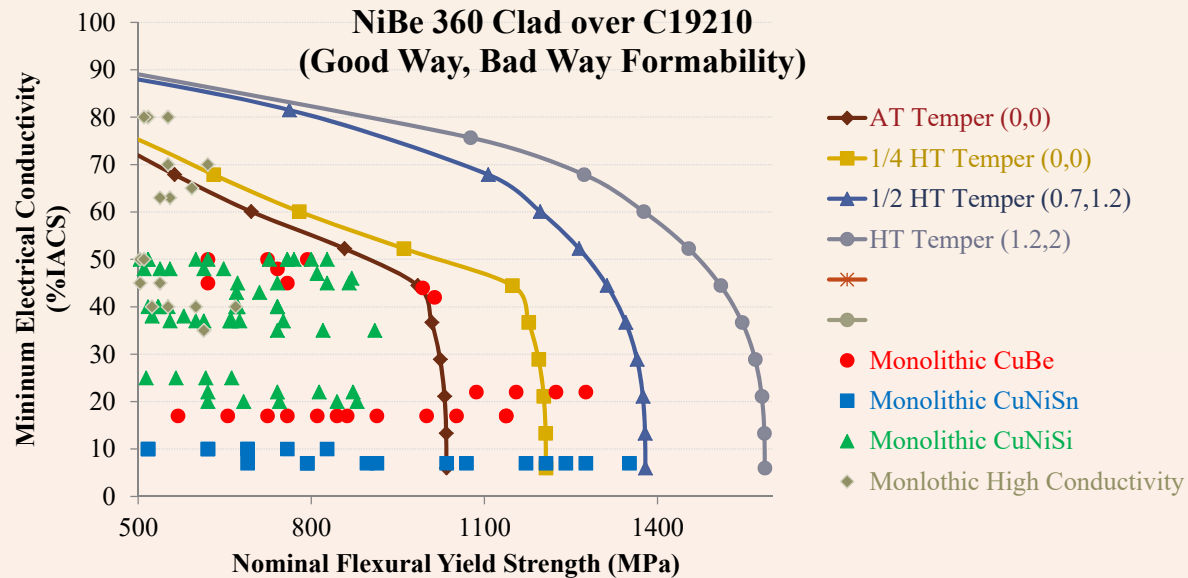
- Composite may not be recyclable
 - Different chemistries
 - No scrap value
- Steel & Cu or Ni & Cu – problem
- Cu alloys – smaller problem

Fabrication Capability

- Different response to stamping clearances
- Different etch rates

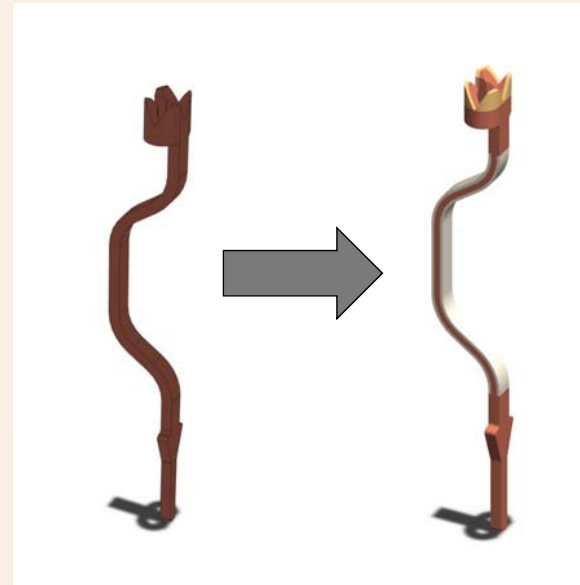
Other Possibilities

- NiBe over high conductivity Cu for high temperature applications



Other Possibilities

- Inlay high strength material in bend area only
- Inlay Paliney or other precious metal in crown area



Conclusions

- Cladding can be used to produce materials with combinations of properties never seen before
- The properties are predictable by simple calculations, confirmed by testing and simulation
- The method used to simulate can be used to estimate properties of composite materials.