

Metal insulator transition materials for socket applications

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- Semiconductor Manufacturing Process
- Test socket
- New Solution

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Metal Insulator Transition Materials

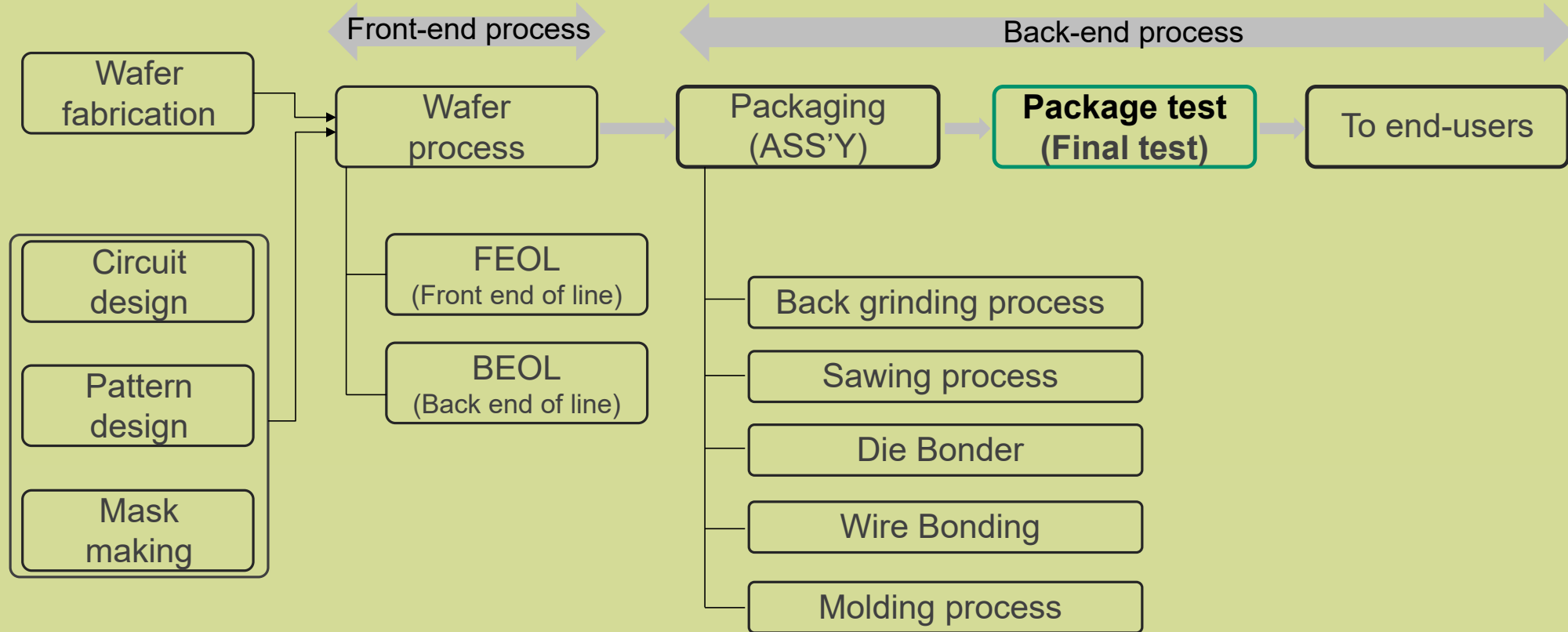
- MITM composite
- MITM surface resistivity test results
- MITM thermal test results

- **Chapter 3.**

Technology Scalability

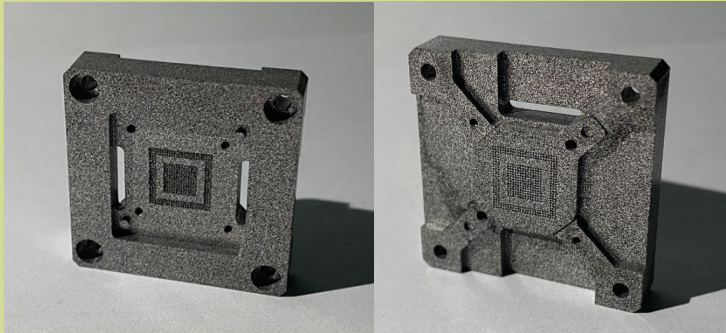
- Electrically Insulated Metal Composites
- Application of MITM
- Technology Scalability

Semiconductor Manufacturing Process



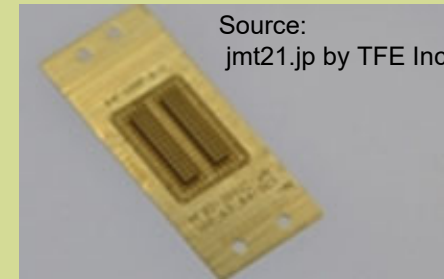
Test Sockets

-Pogo pin-



- High contact accuracy
- High Durability

-Silicone rubber socket-



- High-frequency range available
- Minimize semiconductor devices damage

Polymer and Ceramic based Materials Only till NOW!

Challenges in Advanced Test Socket Materials

- ✓ Compatible with power semiconductors
- ✓ High heat dissipation and durability
- ✓ Antistatic protection
- ✓ Good workability
- ✓ Reasonable Price
- ✓ Etc.

New Solution

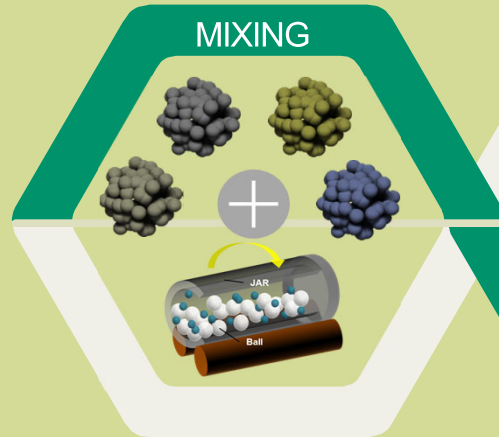
MITM- Aluminum/Magnesium Based Composites



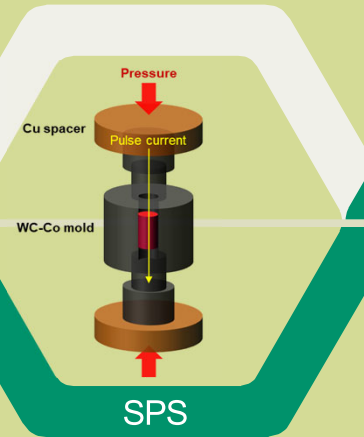
- Metallic based materials
- Controllable surface resistivity (Antistatic)
- High Thermal conductivity and electrical insulator

Experimental procedure

Composite Powders



Machining



Spark plasma sintering

Final Product



ULTRA STRONG



ULTRA DUCTILITY



LIGHT WEIGHT



HIGH THERMAL



ELECTRICAL INSULATION

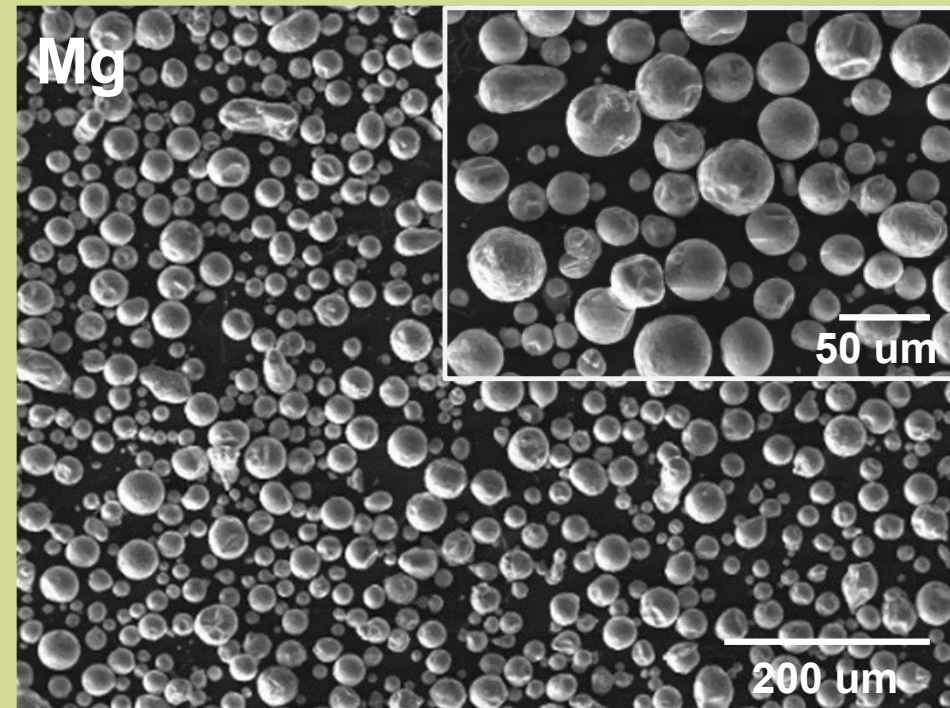
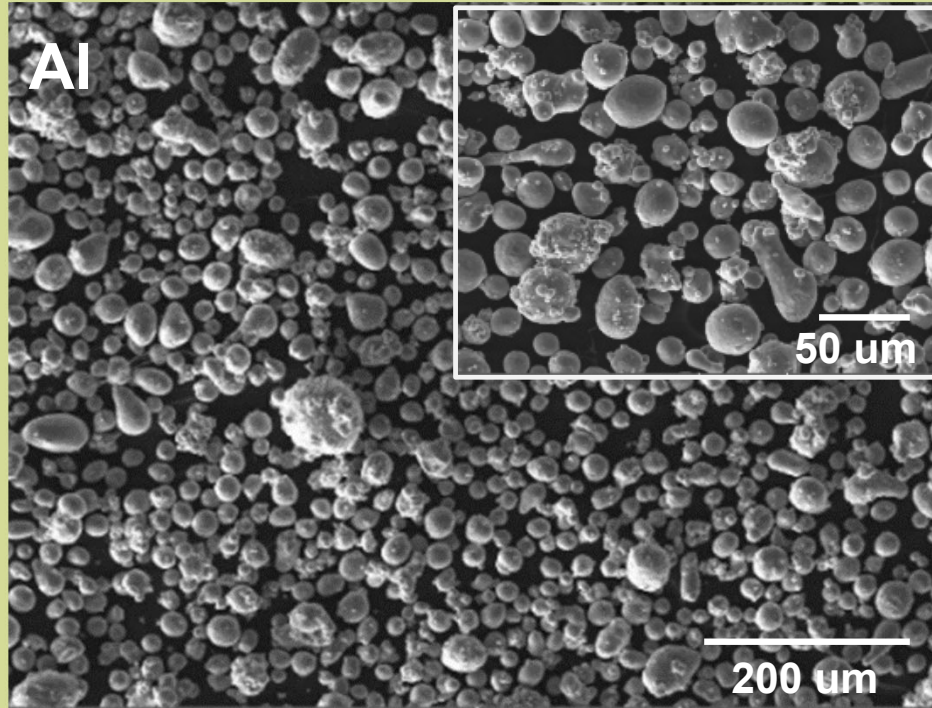


MULTI FUNCTIONAL

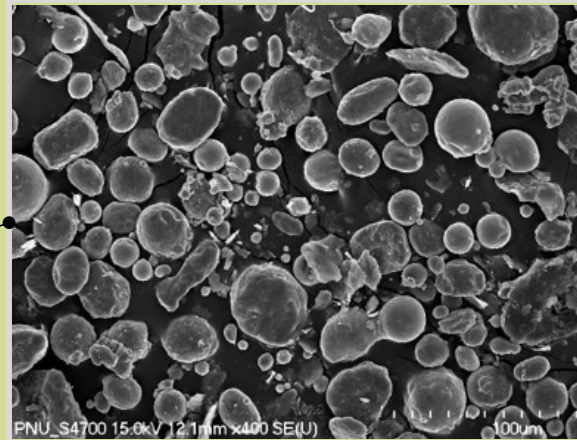
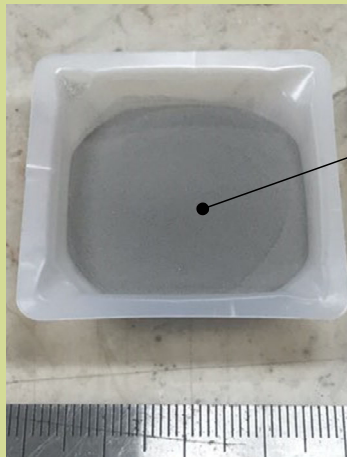


MACHINABILITY

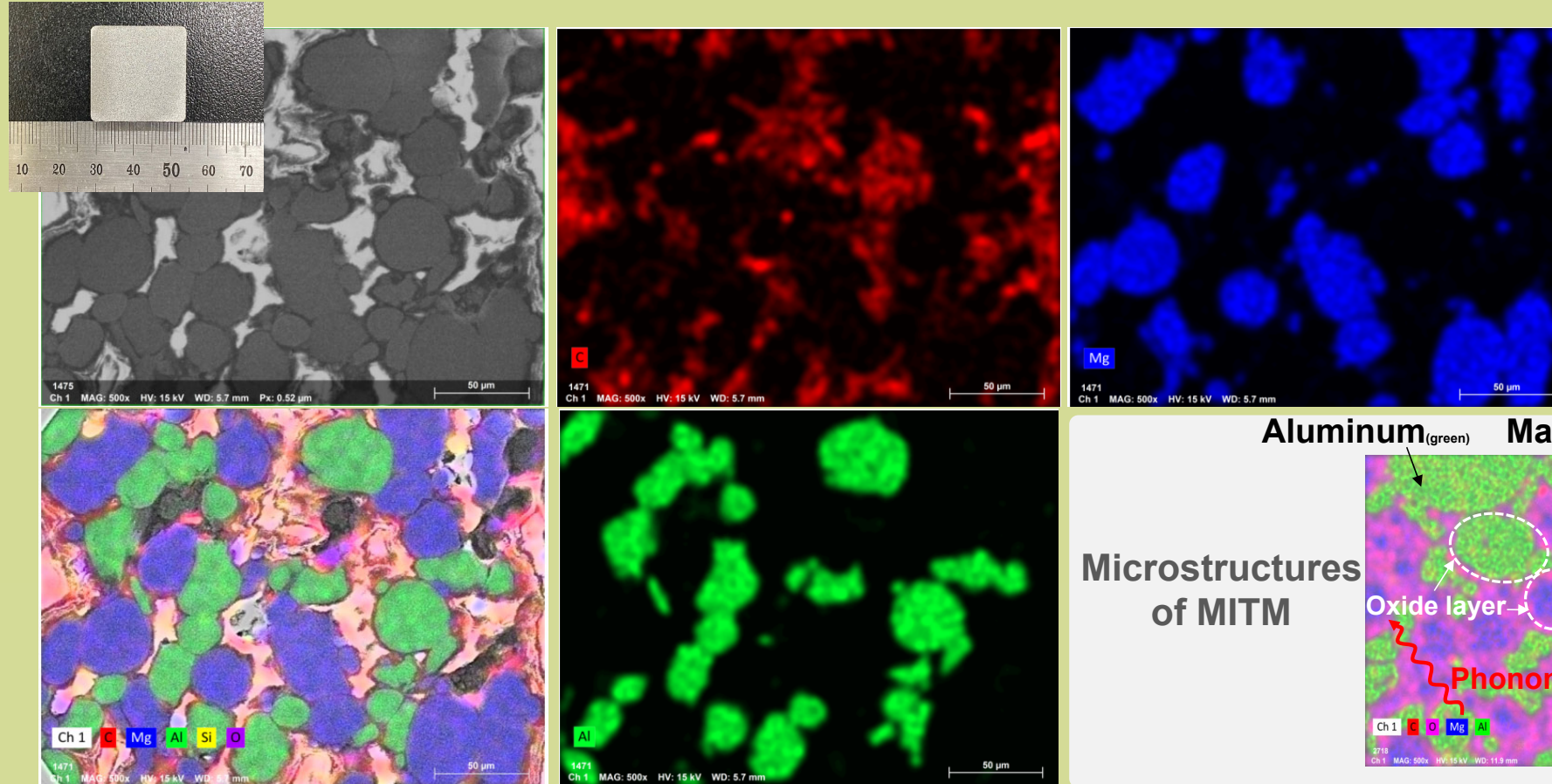
Raw Materials



FE-SEM images of the MITM powder

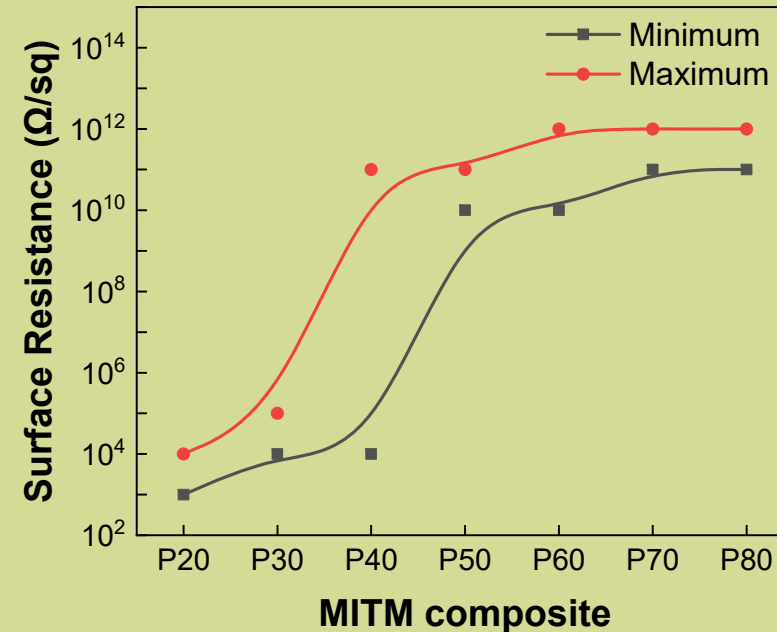


MITM Bulk EDS measurement



Surface Resistance of MITM

Composite	Surface Resistance (Ω/sq)		
	Min	Max	Mean
MITM-20	$<10^3$	10^4	10^3
MITM-30	10^4	10^5	10^4
MITM-40	10^4	10^8	10^6
MITM-50	10^9	10^{11}	10^{10}
MITM-60	10^{11}	10^{12}	10^{11}
MITM-70	10^{11}	10^{12}	10^{12}
MITM-80	10^{11}	10^{12}	10^{12}




Material	Density (g/cm^3)	Heat capacity ($\text{J}/\text{g}\cdot\text{K}$)	Diffusivity (mm^2/s)	Thermal Conductivity ($\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$)	Surface Resistance (Ω/sq)
MITM-50	2.014	0.931	~ 43	~ 80	$\sim 10^{13}$

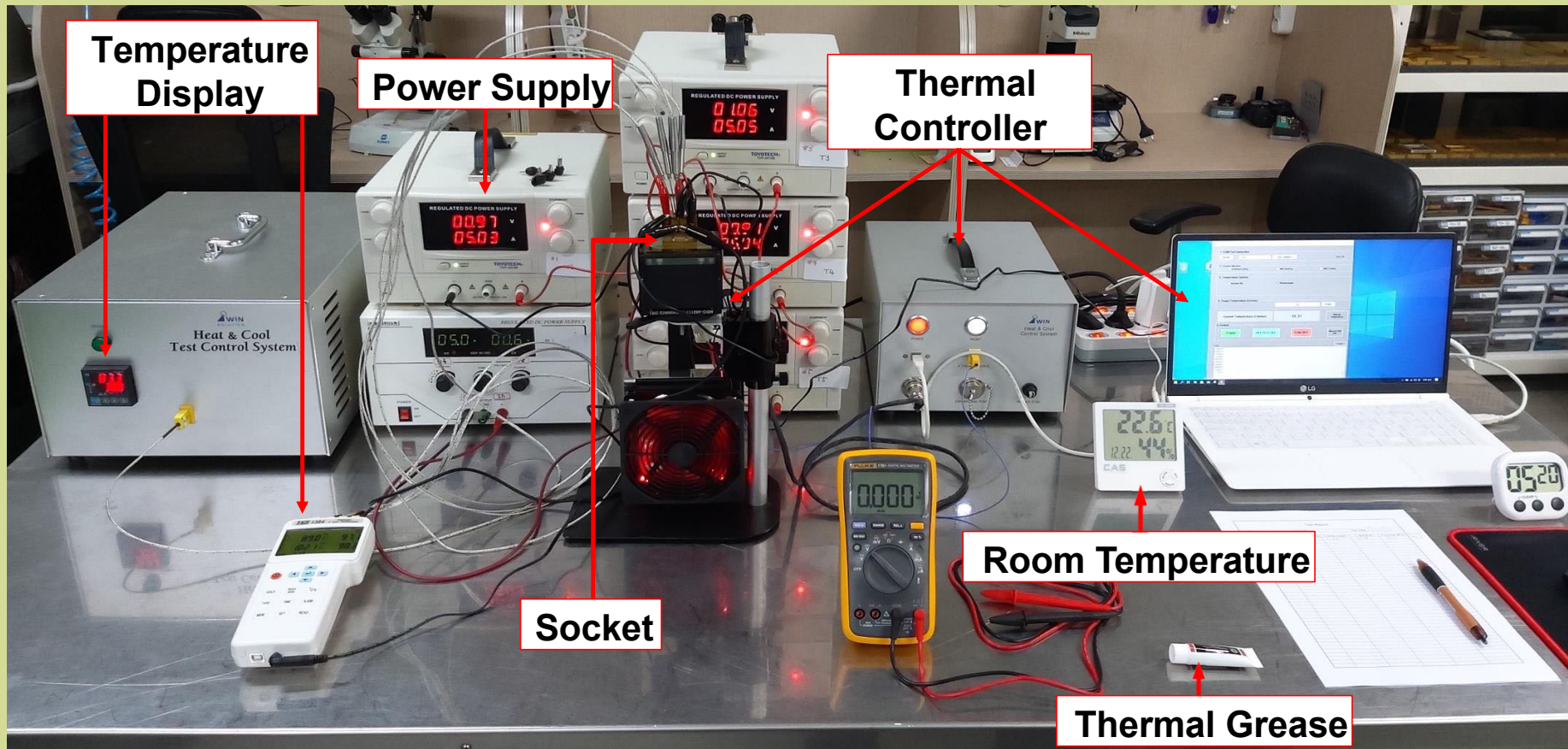


MITM Thermal Test Conditions

- Test conditions:
 - Ambient Temperature: Room Temperature
 - Supply current: 5.0A continuous
 - Parallel circuit connection
 - Test time: 16 hours if parameters are not converged
 - Monitoring parameters: Voltage drop, Barrel(tip) temperature, resistance and force
 - Monitoring interval: 1 hour for voltage drop and barrel temperature
Initial/final status for contact resistance and force

Thermal Test Condition

Tested by  WIN SOLUTION



 **TestConX** 한국
Korea

Metal insulator transition materials for socket applications

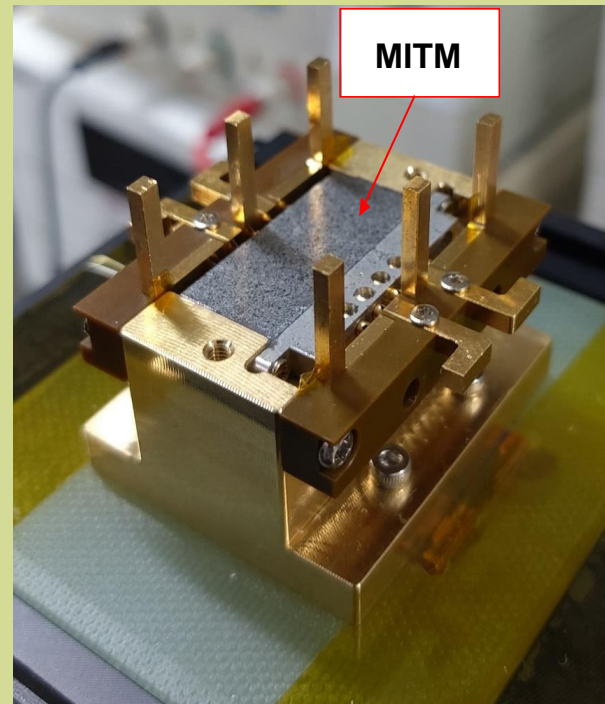
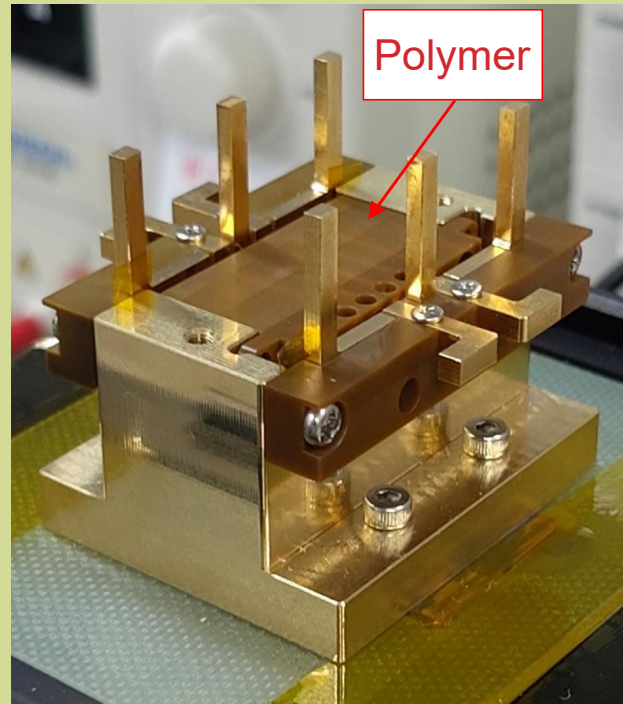
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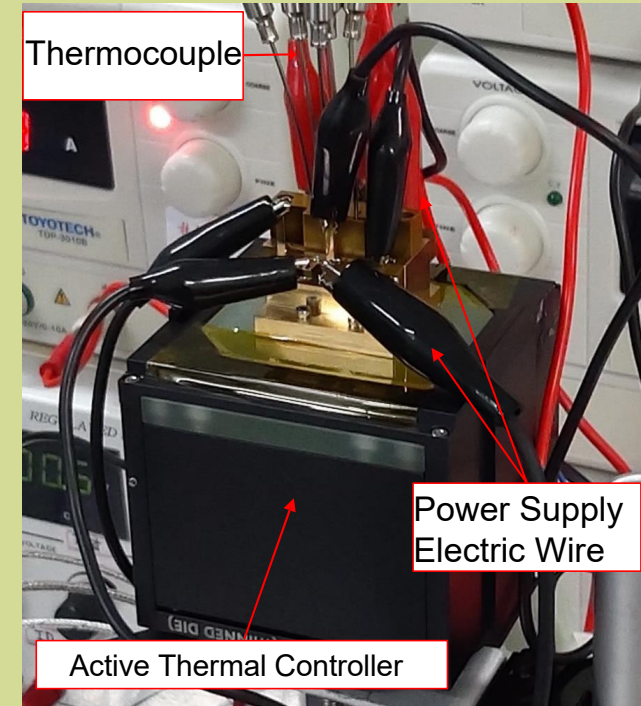


Test with MITM housing – With thermal grease

Assemble to cold plate



Total assy

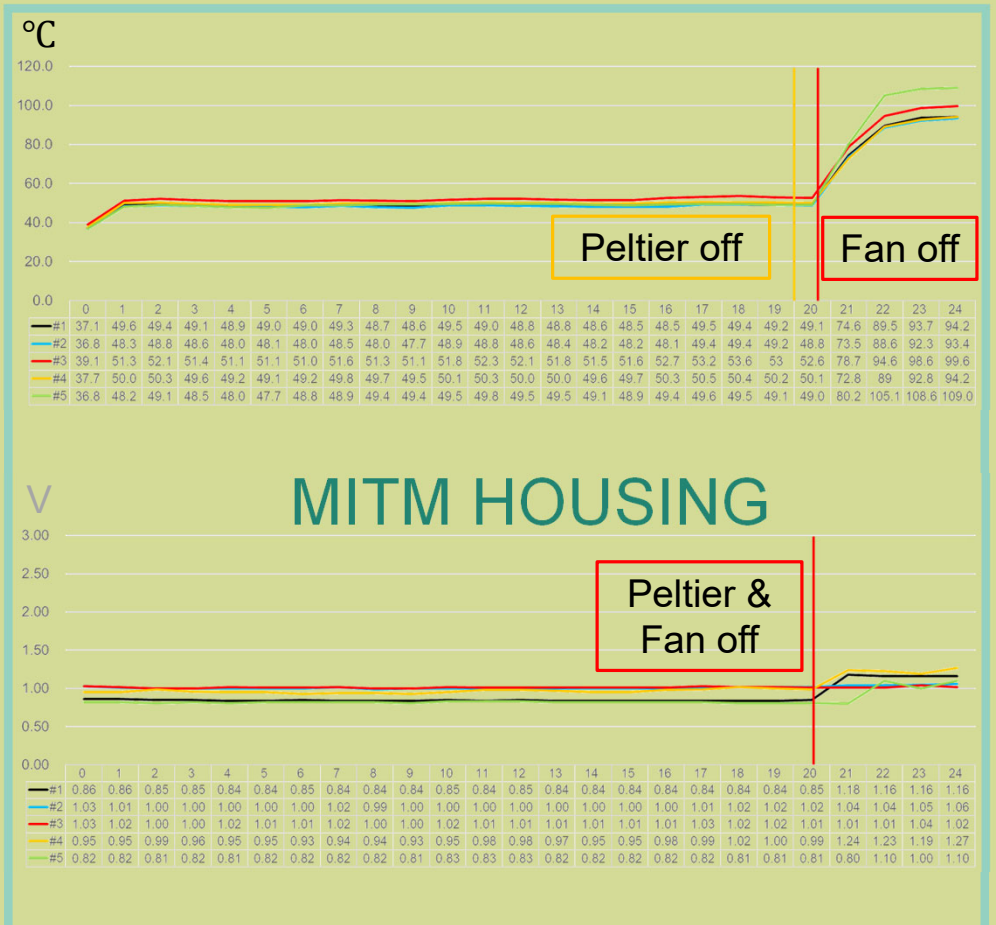
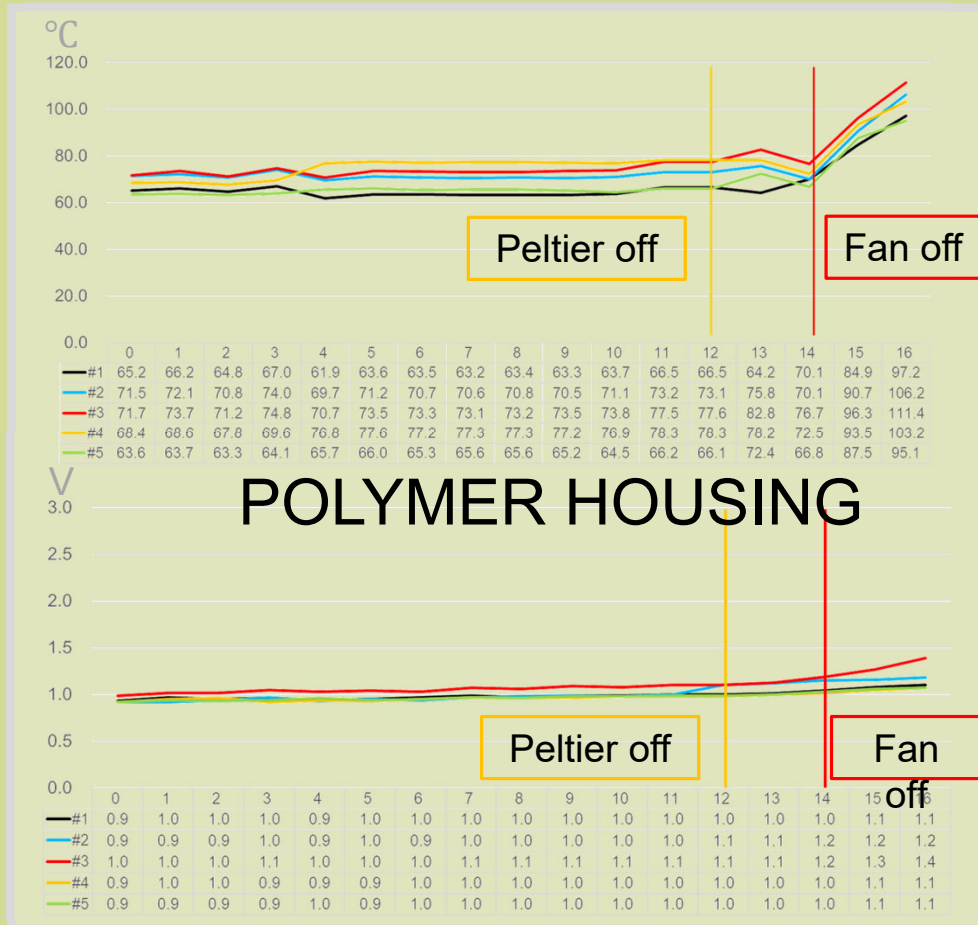


Metal insulator transition materials for socket applications

2023

POLYMER VS MITM

Tested by 



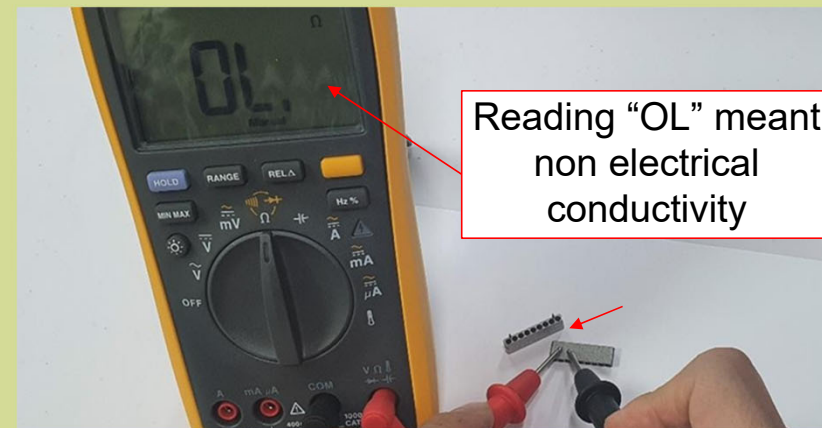
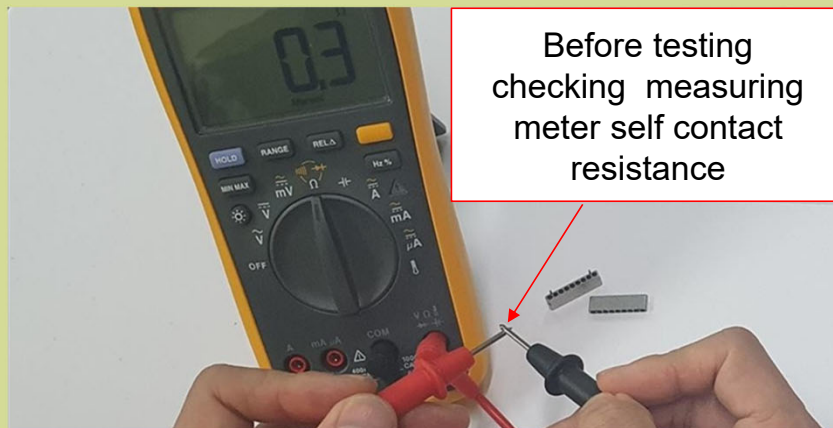
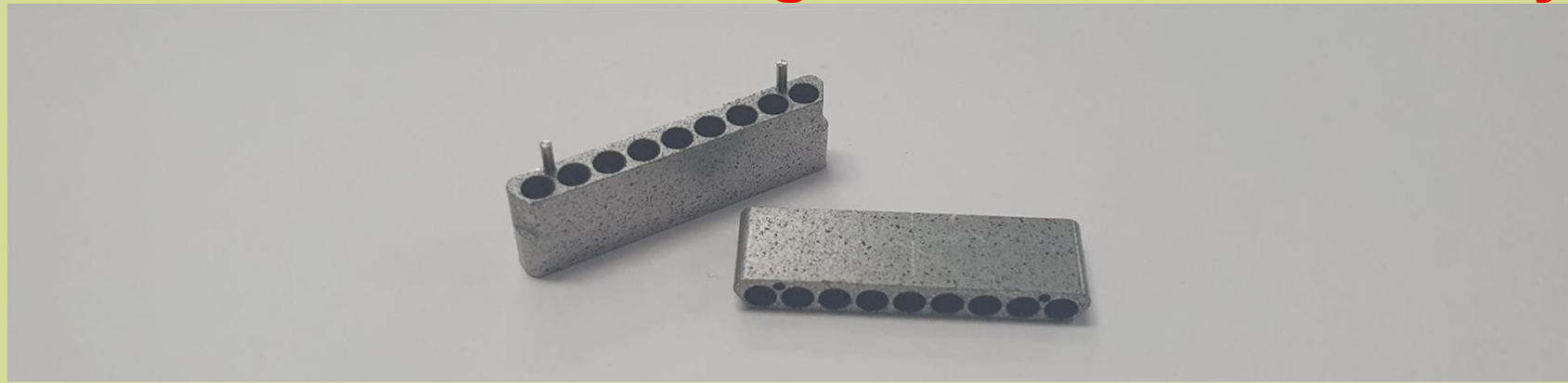
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Metal insulator transition materials for socket applications

2023

Metal housing with electrical insulation, But with **high thermal conductivity**

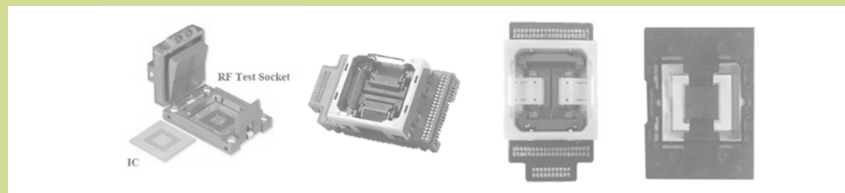
Tested by 



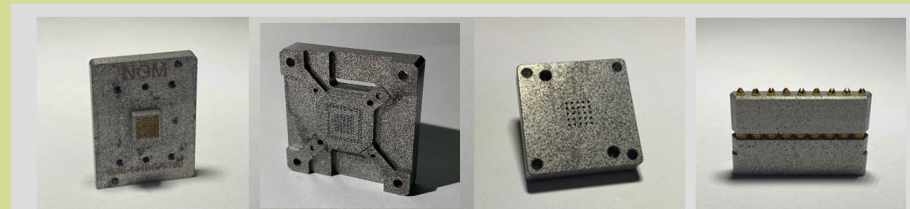
Electrically Insulated Metal Composites

WORLD'S FIRST METALLIC BASED
ELECTRICALLY INSULATED HIGH THERMAL DISSIPATE MATERIALS

CONVENTIONAL TEST SOCKETS



MITM TEST SOCKET

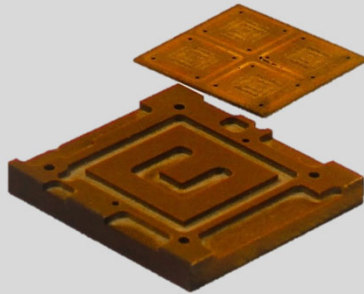


- › Electrical insulator with high thermal conductivity
- › Available for power semiconductor test
- › High reliability and durability

Price Competitiveness of Materials

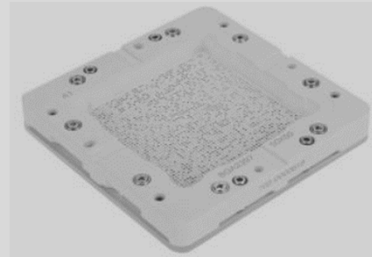
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In General

Polymers



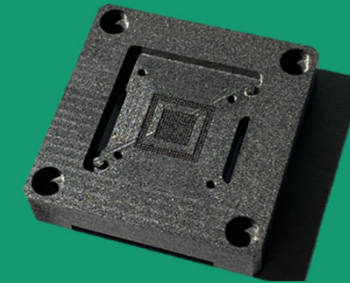
Material unit : about \$9
Socket housing unit : about \$25

Ceramics



Material unit : about \$30
Socket housing unit : about \$150

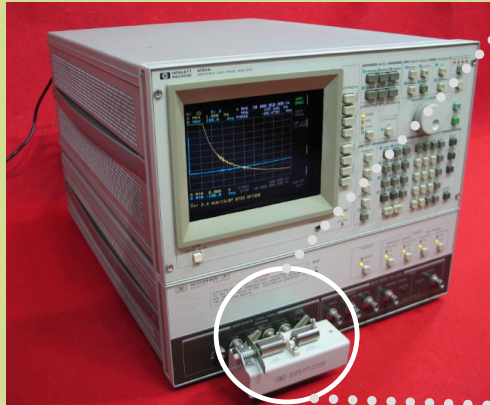
Metal Insulator Transition Material



Can be supplied at a reasonable

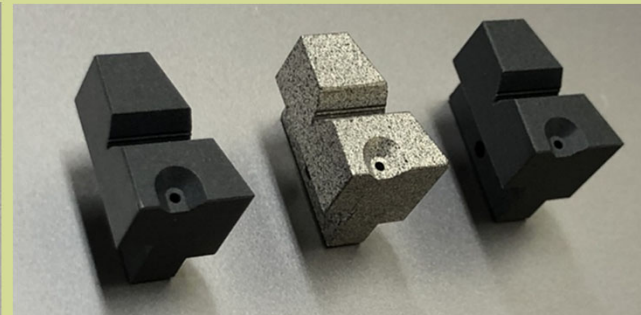
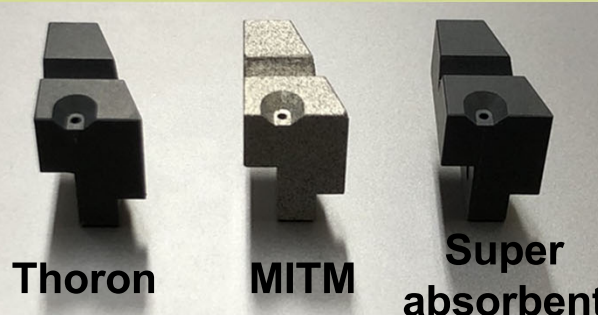
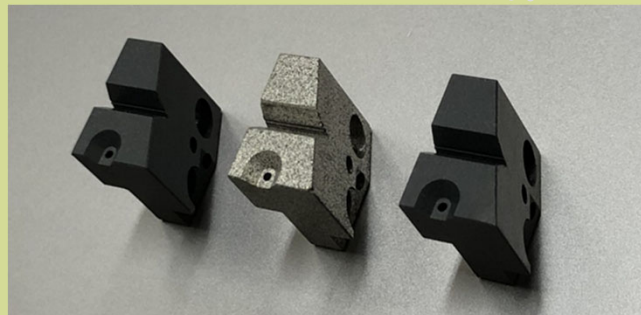
Electrically Insulated Metal Composites

WORLD'S FIRST METALLIC BASED
ELECTRICALLY INSULATED HIGH THERMAL DISSIPATE MATERIALS



In testing electronic equipment such as circuit boards, electronic components, and chips, a test fixture is a device or setup designed to hold the device under test in place and allow it to be tested by being subjected to control electronic test signals

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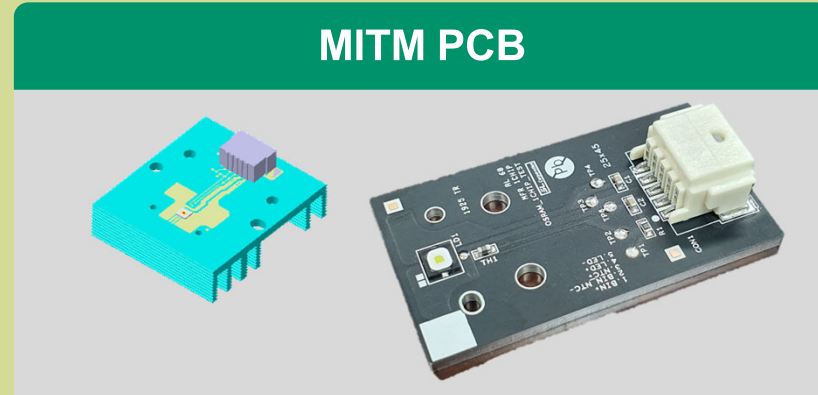


Application of MITM

Polymeric & metallic
PCB



MITM PCB



Application of MITM powder



Ex. Silicone Rubber Socket

- ✓ Controllable of surface resistance
- ✓ High heat dissipation and electrical insulator
- ✓ Good mechanical performance
- ✓ Improved durability

Technology Scalability



Vehicle industry

- > Battery Managed System(BMS)
- > Air Conditioning System Materials
- > Sensor and Control Unit Materials



Electronics industry

- > Electronic Devices
- > Wireless Transmitter
- > Radiation & Electromagnetic Shielding



Computer industry

- > Computer and Device Cases
- > Heatsinks
- > Electromagnetic Shielding



Frame & Robot System

- > Solar Power Generation System
- > Factory Automation Equipment
- > Robot System



Construction materials

- > High-performance Building Materials
- > Lightweight High Tension Cable
- > Hydraulic Cylinder Parts



Aerospace industry

- > Urban Air Mobility (UAM)
- > Satellite and Space Shuttle
- > Lightweight Structural Materials

Short Summary

- A metal-based composite material for a semiconductor test socket housing was successfully fabricated by a powder metallurgy process.
- The fabricated metal-insulator transition material (MITM) was shown to have high thermal conductivity with an excellent electrical insulator.
- In particular, surface resistance can be controlled in the MITM, which is effective in preventing static electricity.
- It is expected to be effective in testing power semiconductors requiring relatively high currents.
- MITM could be used as a metallic-based test socket housing along with conventional polymer and ceramic test socket housings.
- MITM is the world's first metallic-based socket material introduced in the semiconductor test field.
- It can be used not only as a socket material but also as an industrial material necessary for high heat dissipation with electrical insulators.

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