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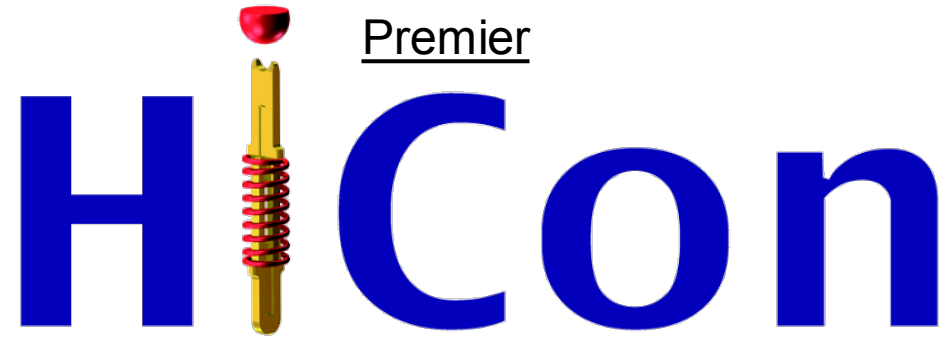
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Mesa, Arizona
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Metal insulator transition materials for next generation semiconductor test socket

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Pukyong National University



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- Technology Scalability



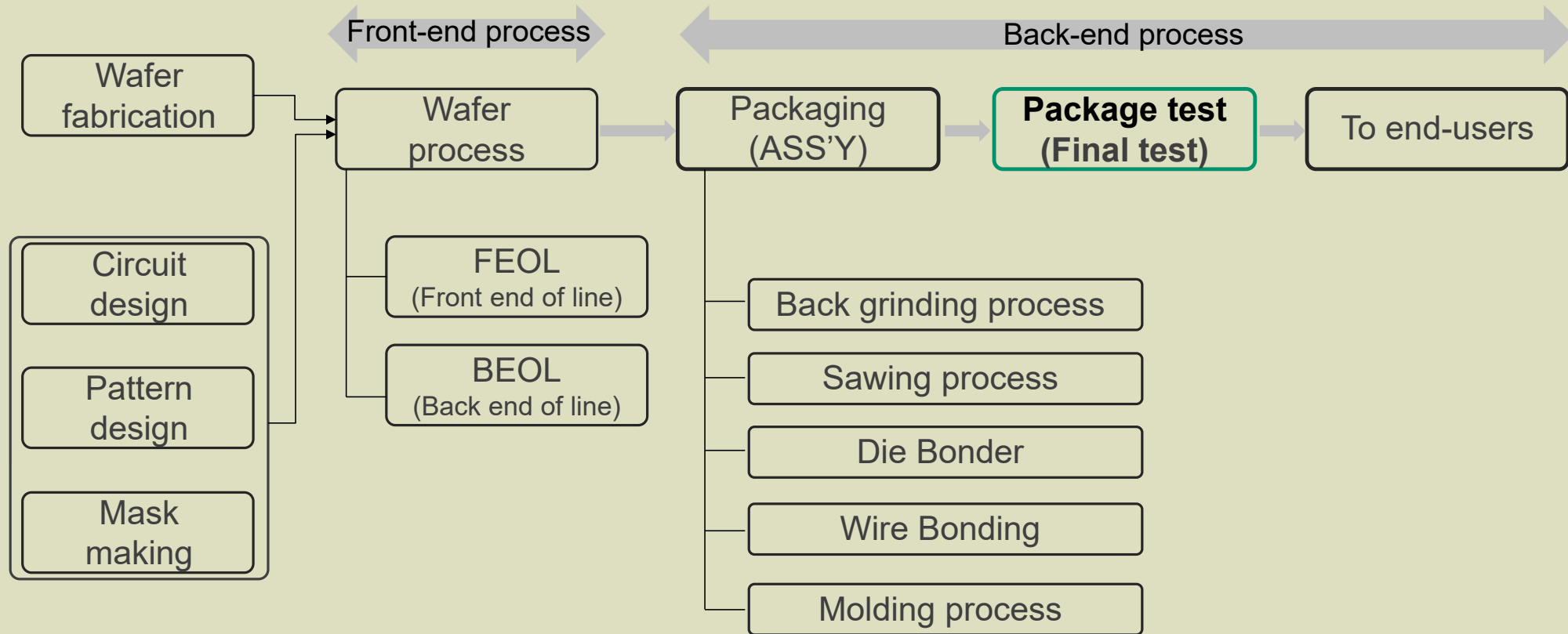
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Semiconductor Manufacturing Process

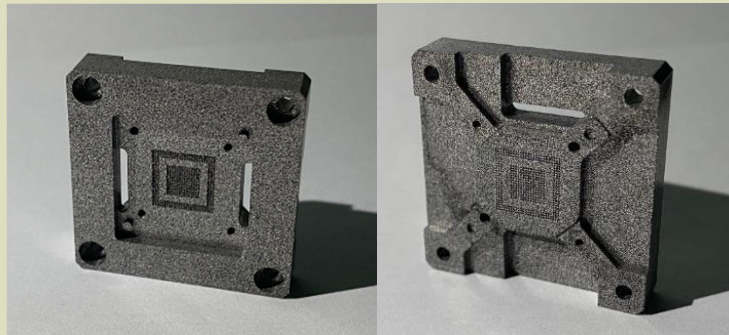


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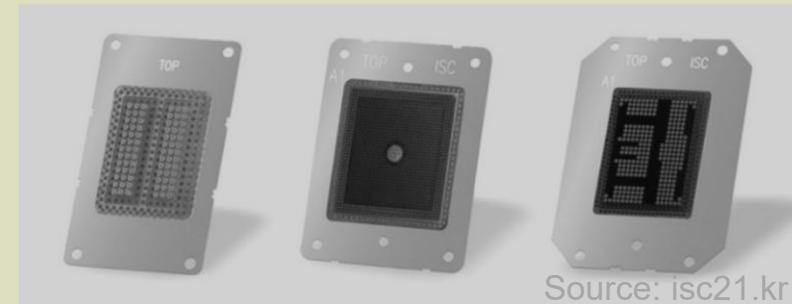
Test Sockets

-Spring 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.



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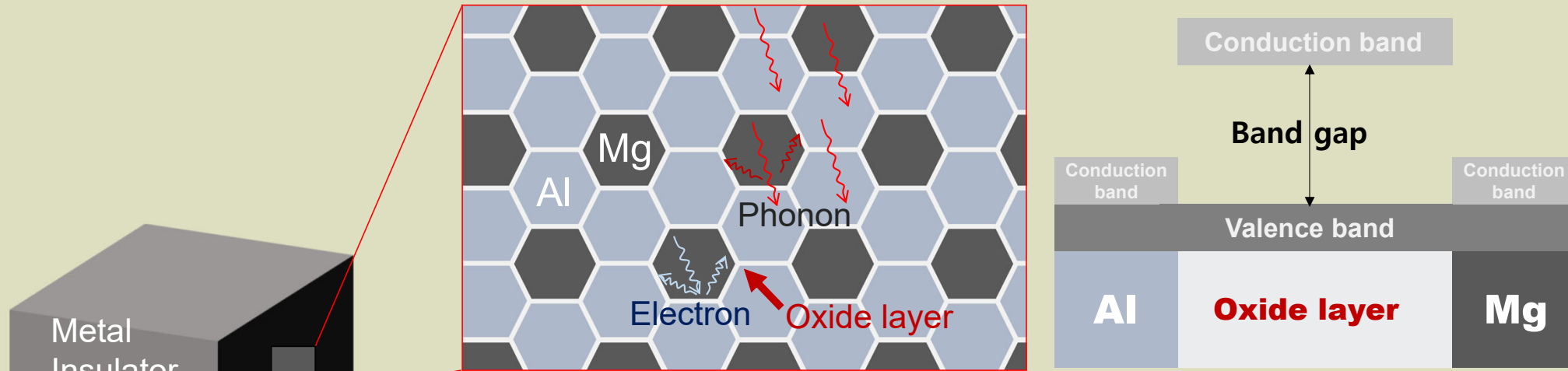
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New Solution

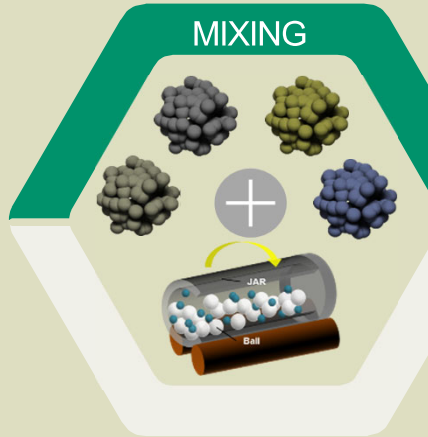
MITM- Aluminum/Magnesium Based Composites



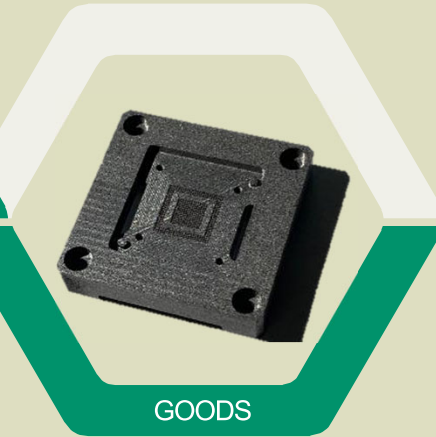
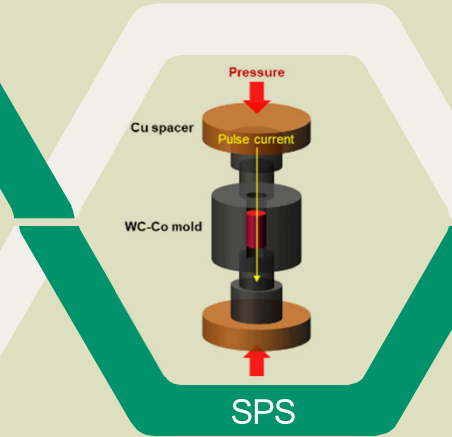
- Metallic based materials
- Controllable surface resistivity (Antistatic)
- High Thermal conductivity and electrical insulator

Experimental procedure

Composite Powders



Machining



Spark plasma sintering

Final Product



ULTRA STRONG



ULTRA DUCTILITY



LIGHT WEIGHT



HIGH THERMAL



ELECTRICAL INSULATION



MULTI FUNCTIONAL



MACHINABILITY



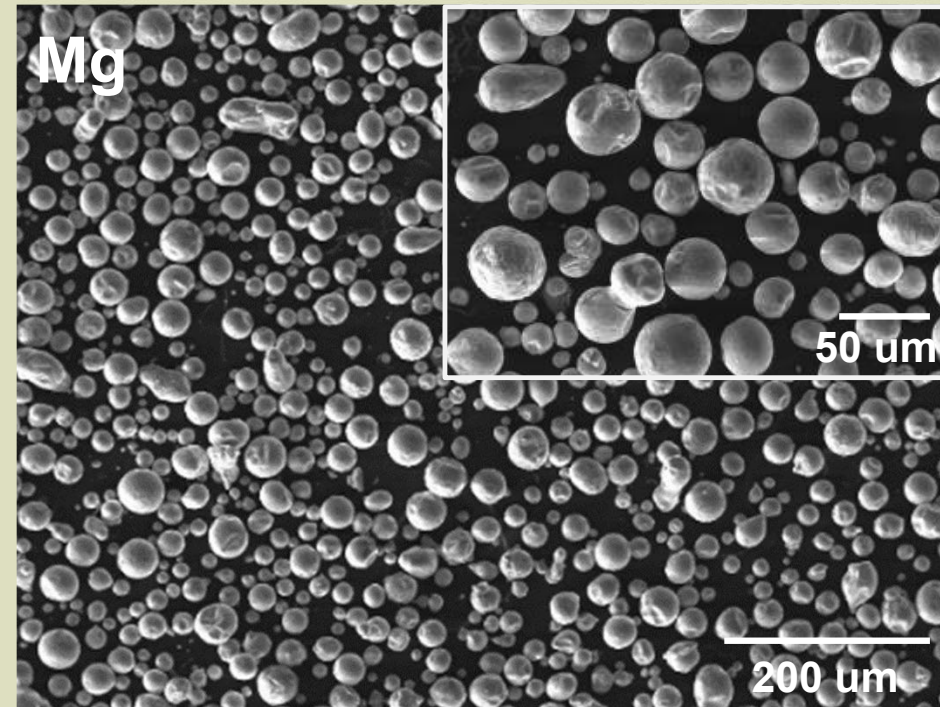
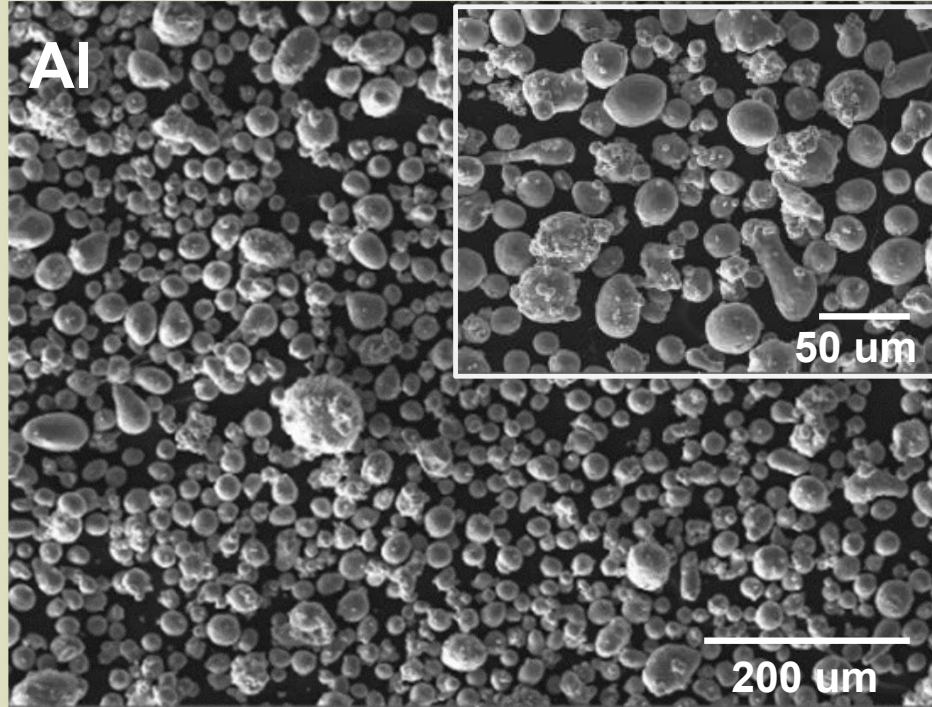
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Raw Materials



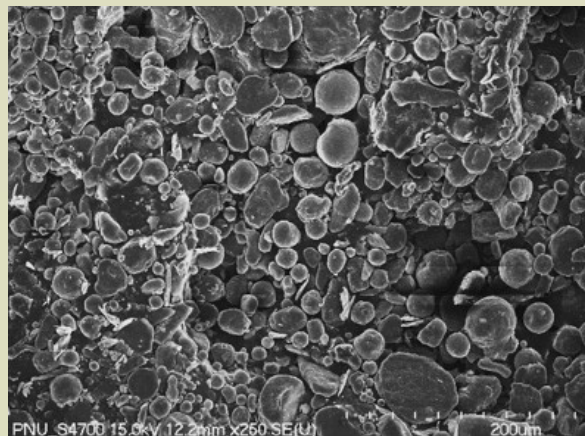
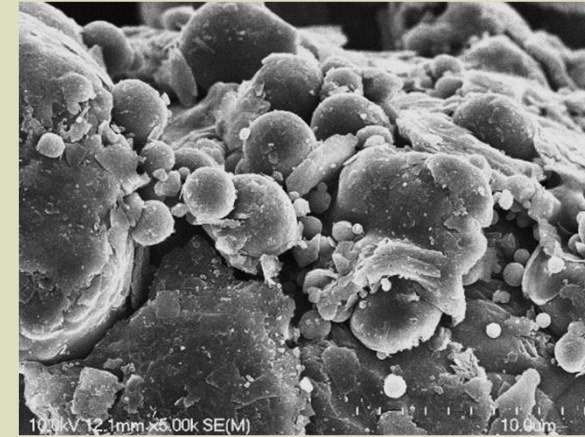
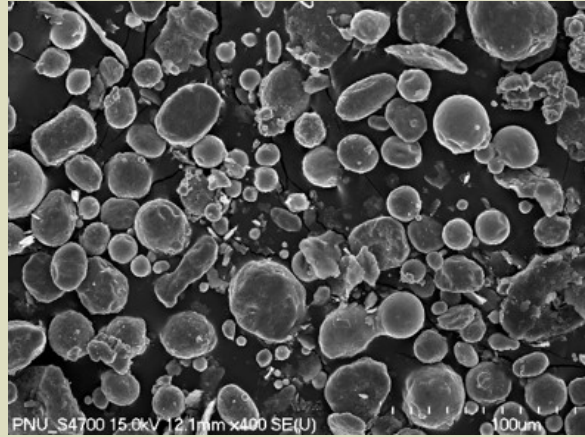
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FE-SEM images of the MITM powder

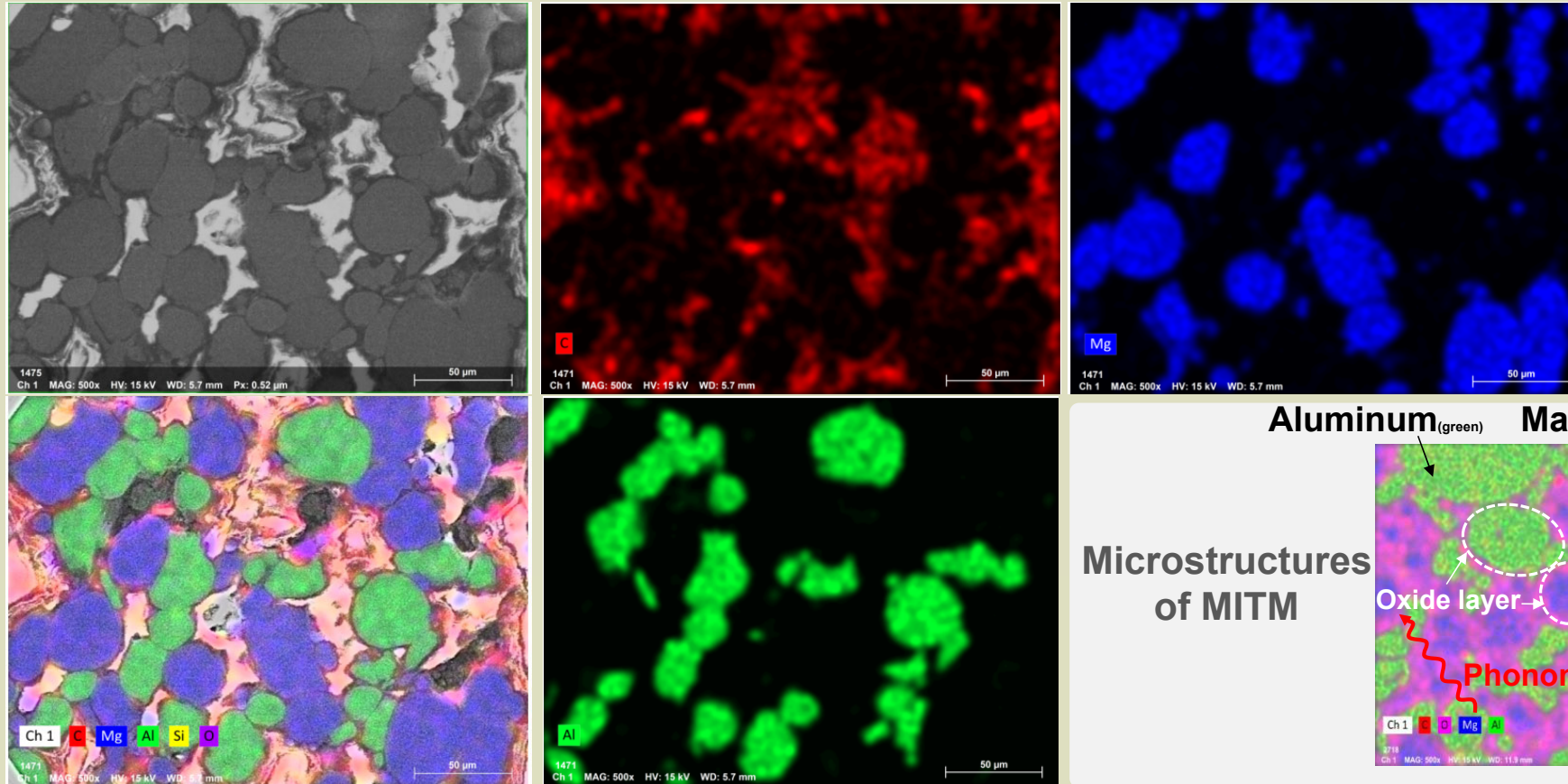


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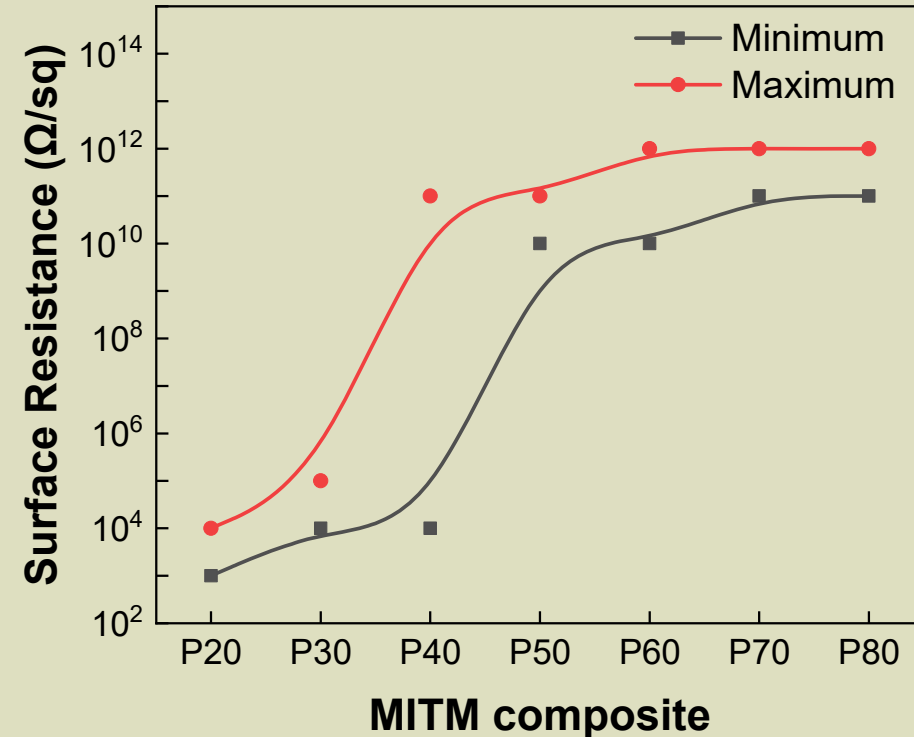
MITM Bulk EDS measurement



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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}



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MITM-Some Property

Material	Density (g/cm ³)	Heat capacity (J/g·K)	Diffusivity (mm ² /s)	Thermal Conductivity (W·m ⁻¹ ·K ⁻¹)	Surface Resistance (Ω/sq)
MITM-50	2.014	0.931	~43	~80	~10 ¹³



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MITM Thermal Test Conditions

- Test conditions:
 - Ambient Temperature: 22.5~23 °C
 - Supply current: 5.0A continuous
 - Parallel circuit connection
 - Test time: 12 hours (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



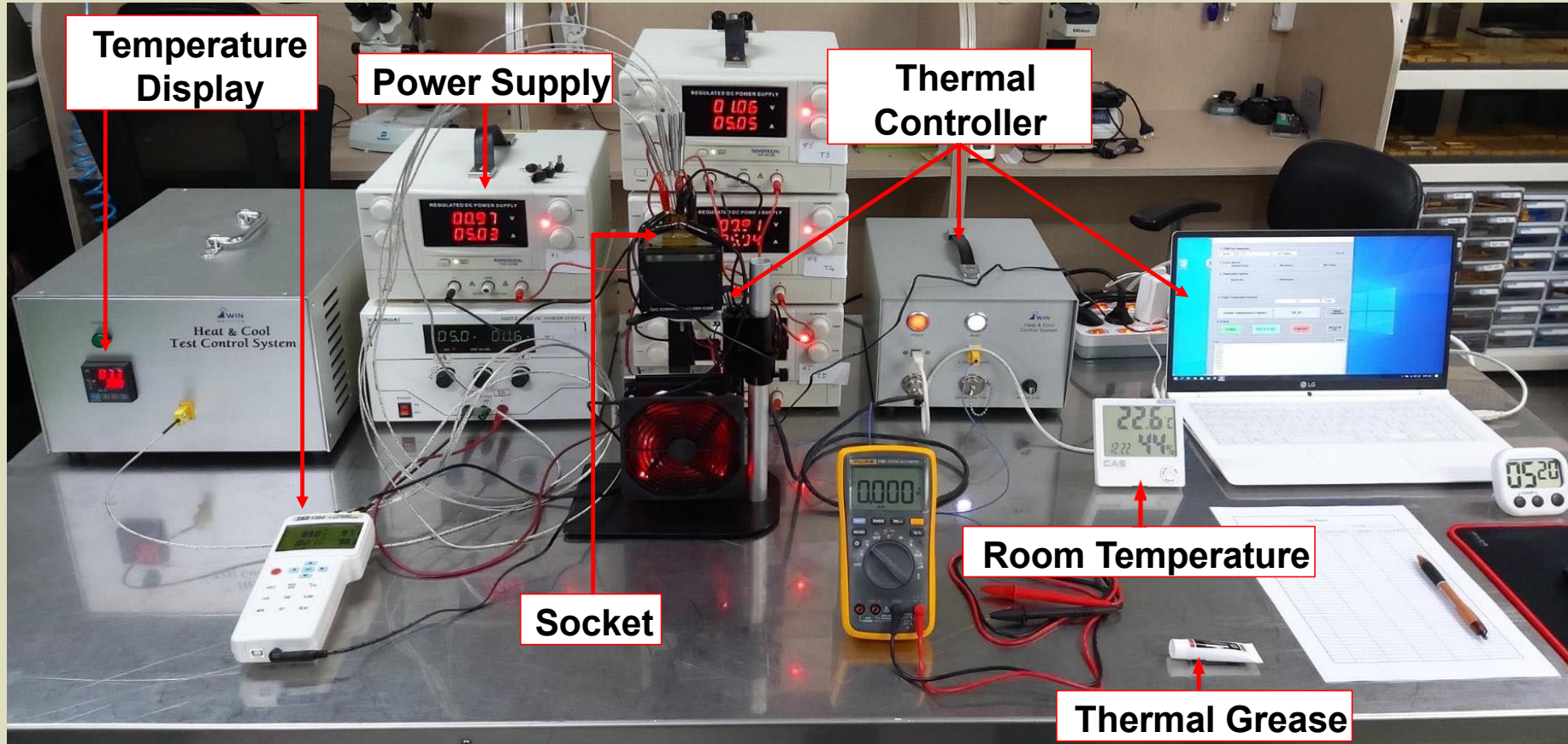
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Thermal Test Condition



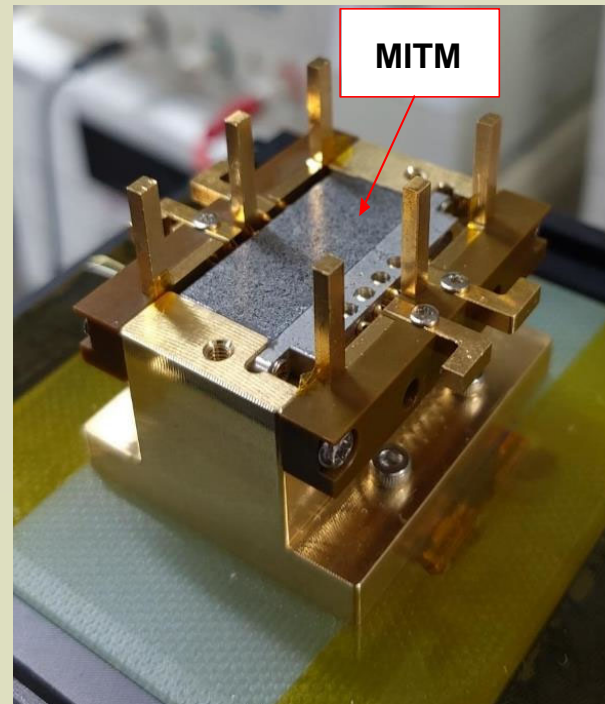
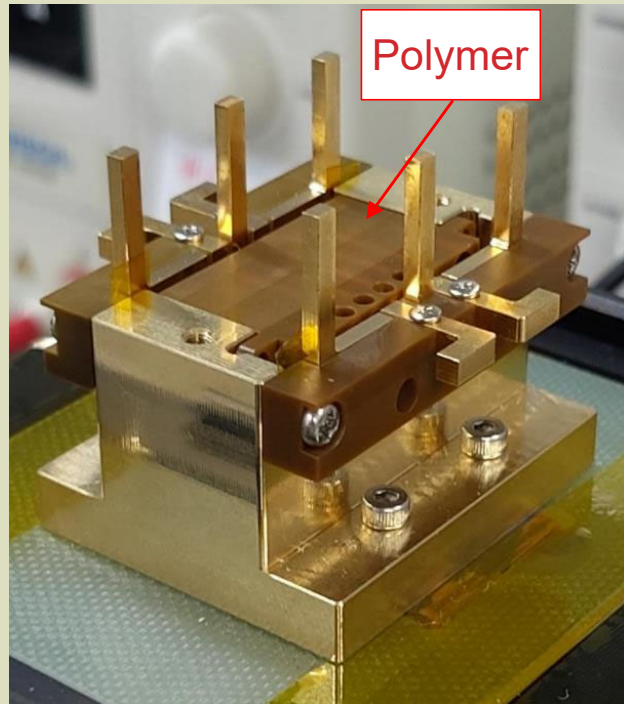
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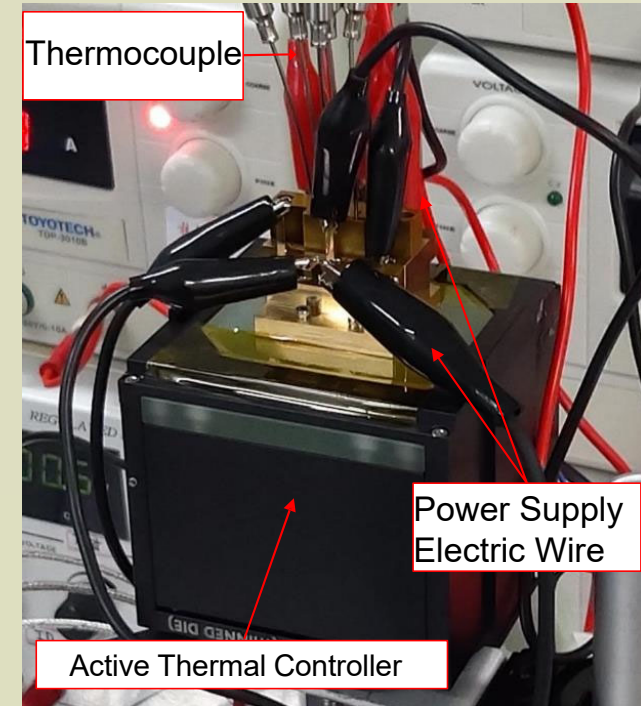
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Test with MITM housing – With thermal grease

Assemble to cold plate

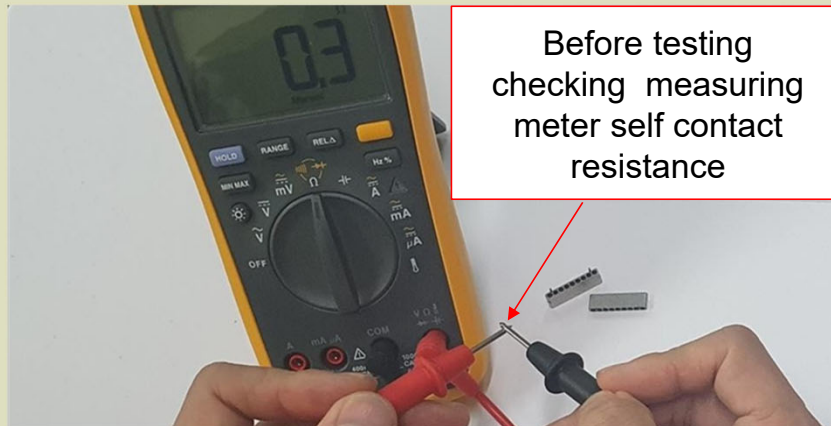
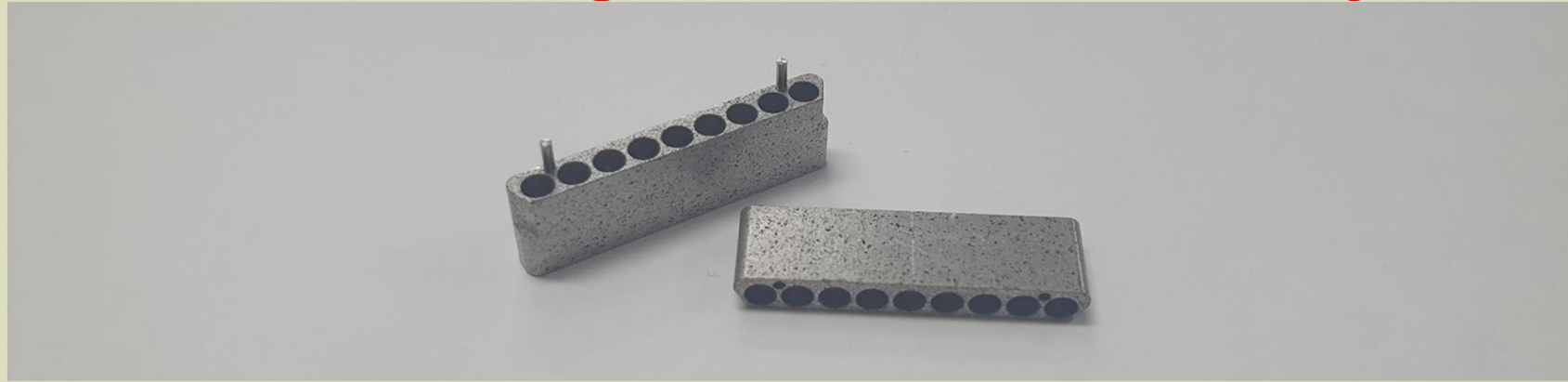


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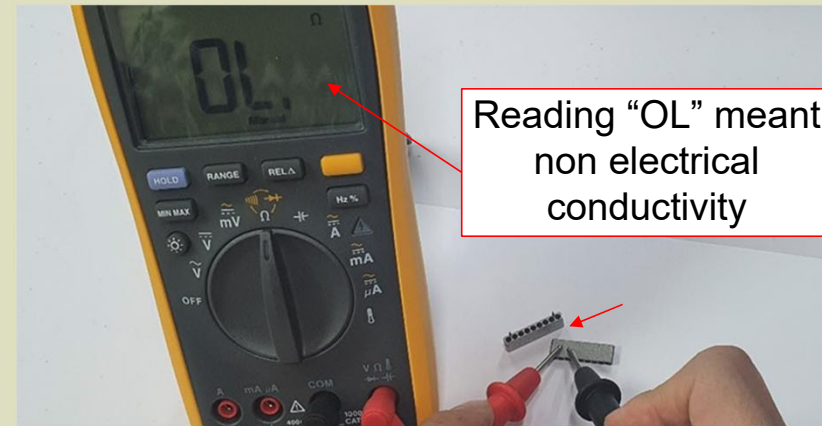


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Metal housing with electrical insulation, But with **high thermal conductivity**



Before testing
checking measuring
meter self contact
resistance



Reading "OL" meant
non electrical
conductivity

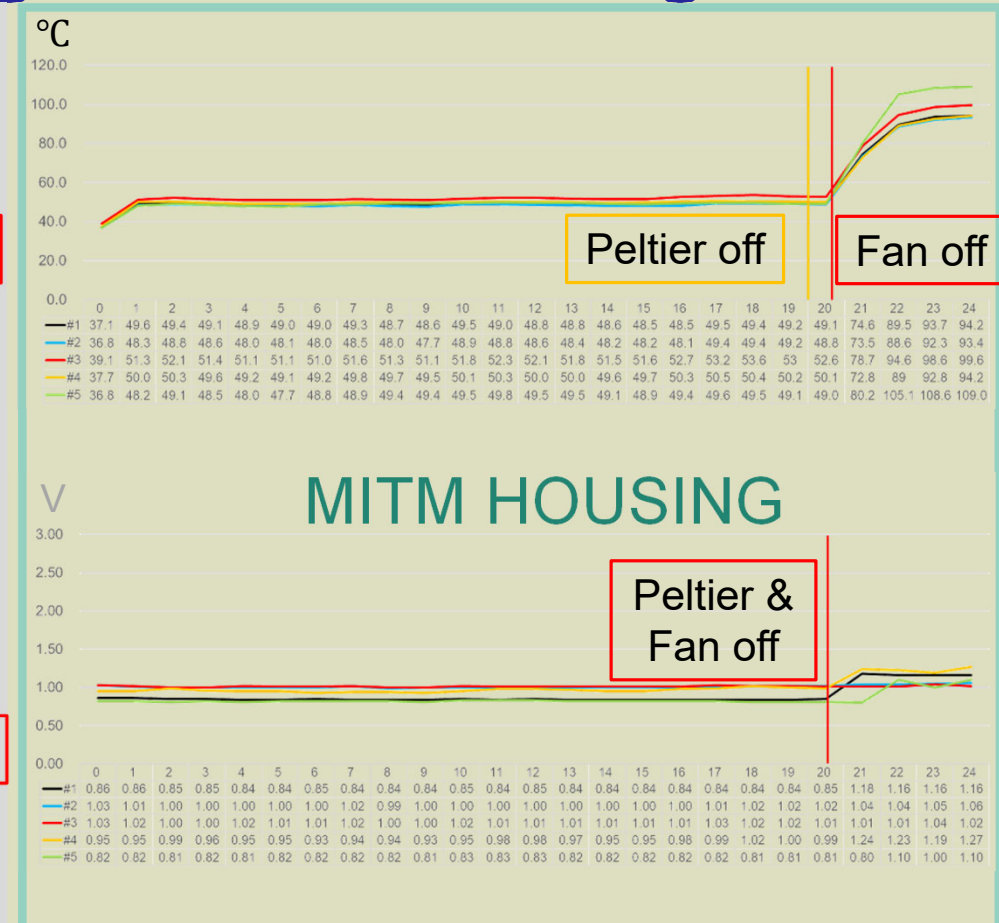
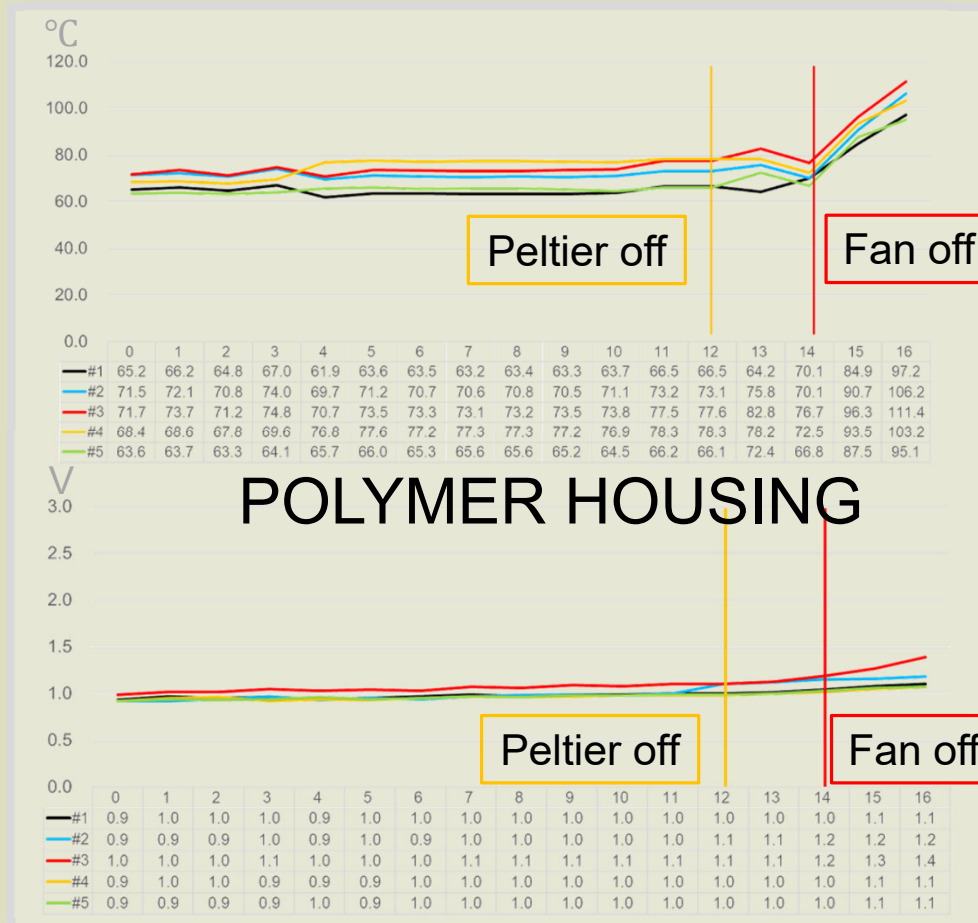


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POLYMER Housing VS MITM Housing



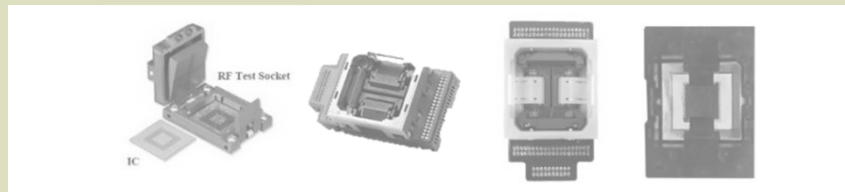
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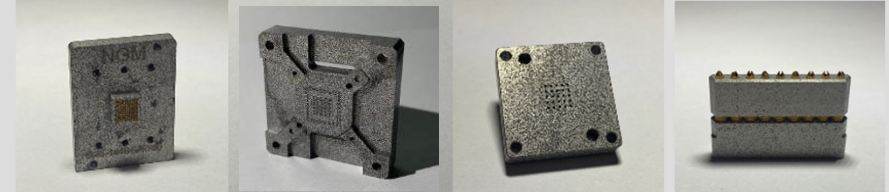
Electrically Insulated Metal Composites

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

CONVENTIONAL TEST SOCKETS



MITM TEST SOCKET



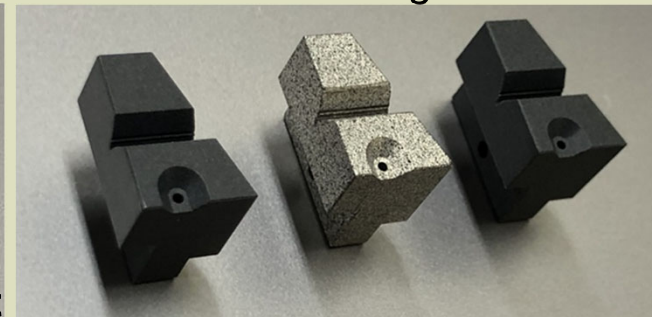
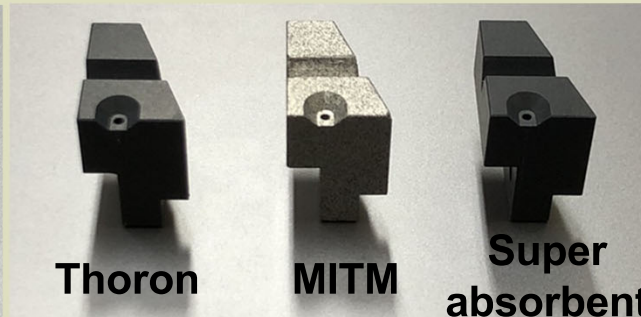
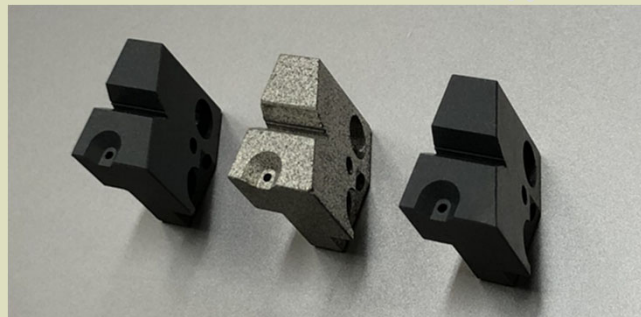
- Electrical insulator with high thermal conductivity
- Available for power semiconductor test
- High reliability and durability

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Electrically Insulated Metal Composites

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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

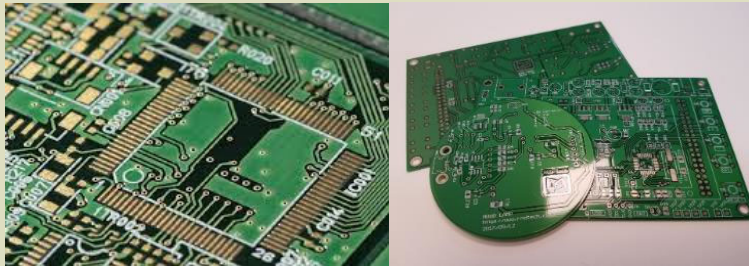


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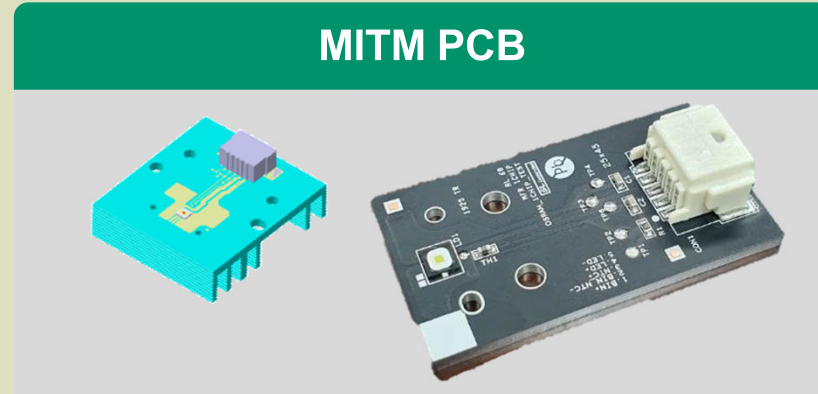
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Application of MITM

Polymeric & metallic
PCB



MITM PCB



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Application of MITM powder



Ex. Silicone Rubber Socket

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



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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 Matl's
- ▶ Lightweight High-Tension Cable
- ▶ Hydraulic Cylinder Parts



Aerospace industry

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



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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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