# HIGH-PERFORMANCE LOW-LOSS CERAMIC FILLER WITH ENHANCED SURFACE FOR NEXT-GENERATION THERMAL MANAGEMENT IN ELECTRONICS

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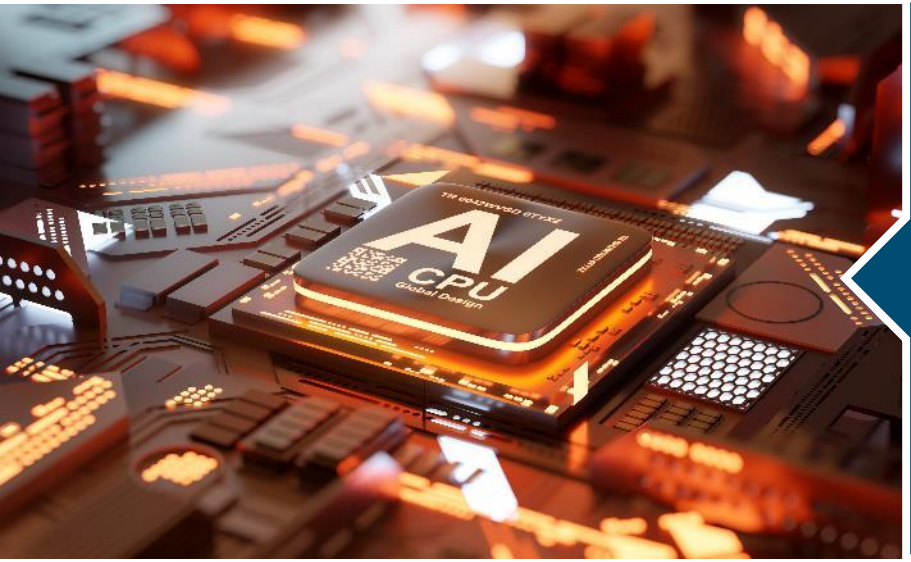
# Advanced Materials for Advanced Technologies

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We are an **Advanced Materials Company** engaged in the design and manufacture of ultra-high-performance **quartz crucibles**, **quartz products** and **ceramic** products.

Our products are vital to the semiconductor industry, enabling the production of logic and memory chips, power control devices, and multiple systems for electric vehicles.





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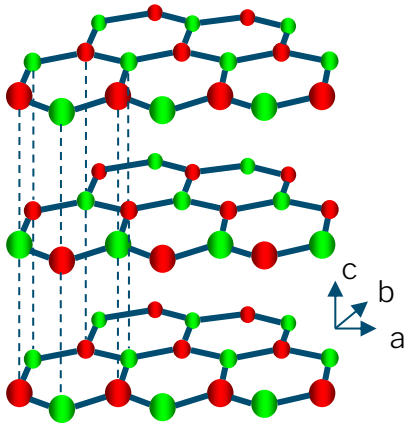
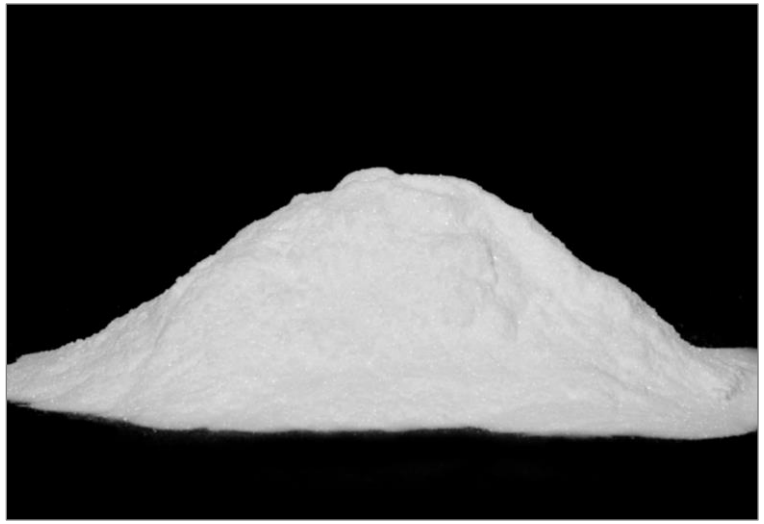
# Hexagonal Boron Nitride For Thermal Management

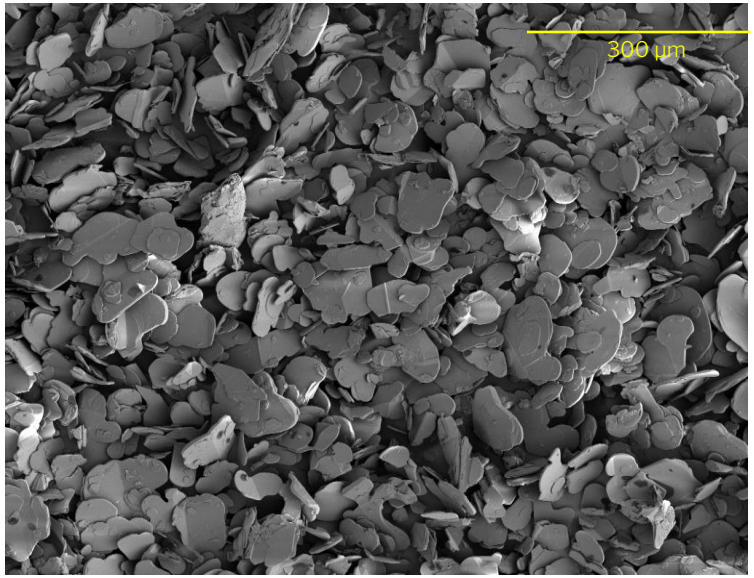
## Crystal Structure of Hexagonal Boron Nitride (h-BN)




## Key Features and Typical Benefits

- High thermal conductivity
- High electrical resistivity
- High thermal stability
- Low dielectric constant






## Typical properties of Hexagonal Boron Nitride (h-BN)

| Property | Typical Value* |
|---|---|
| Theoretical density | 2.25 g/cm$^3$ |
| Thermal conductivity | 300 W/mK$^{\dagger}$ |
| Volume resistivity | $10^{15}$ Ohm-cm |
| Dielectric constant | 3.9 |
| Mohs hardness | 1.5 |

*Typical properties are average data and are not to be used as or to develop specifications.
†In-plane conductivity in the a-b plane of the crystal

# For More Severe Insulation and Thermal Challenges

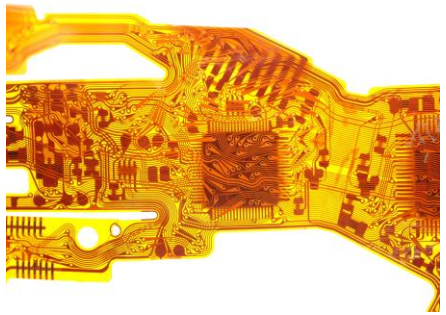


Electrical Vehicle


High Frequency Telecommunication

Thermal Management Challenges

LED Lighting



Consumer Electronics

*BN Solution:*

- *Higher thermal conductivity (TC)*
- *Higher electrical resistivity*
- *Thinner bond line thickness (BLT)*
- *Lower dielectric constant (Dk)*
- *Good mechanical compliance*
- *Lighter weight*





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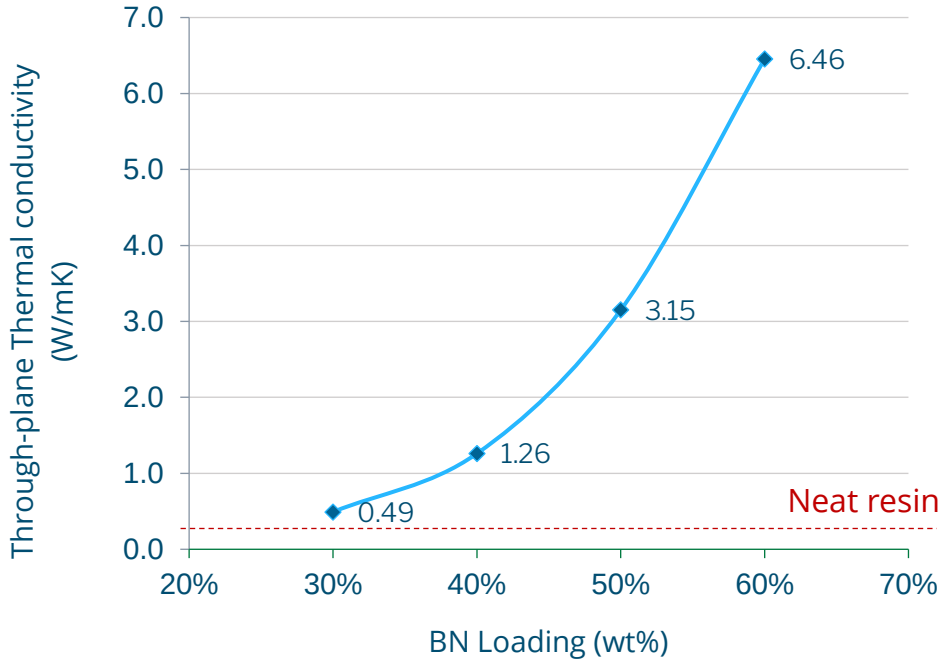
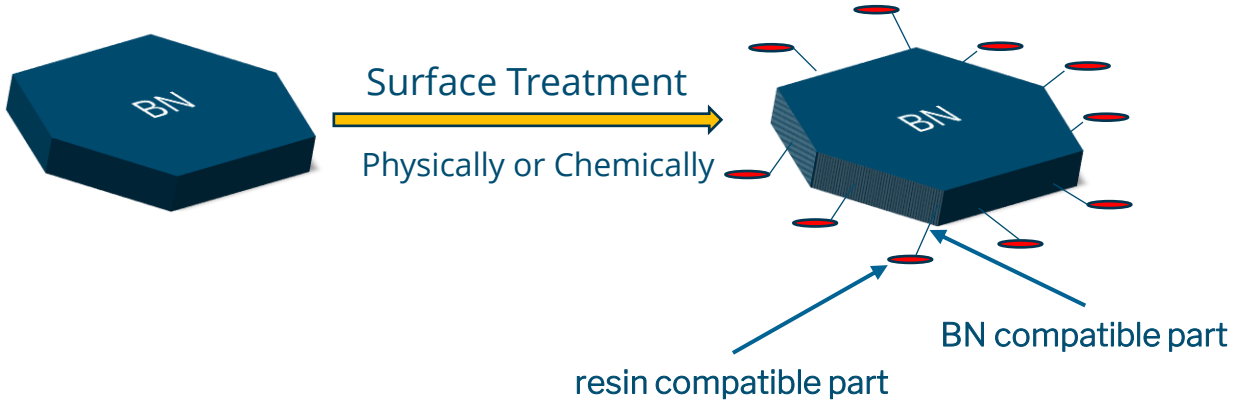
# Viscosity Increase Put A Limit On TC of BN Filled Resins

## TC of BN filled silicone @ various loadings




Surface modification (chemically or physically) on BN powder surface without damaging crystallinity to enable higher BN loading with acceptable viscosity to TIMs.

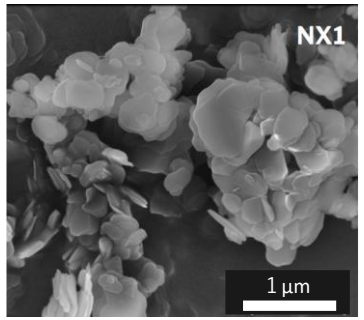


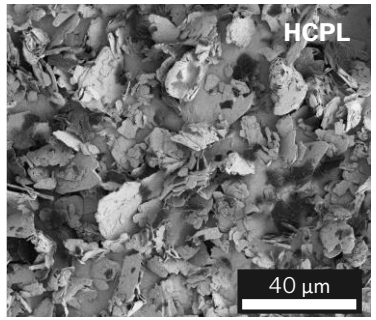

Max BN loading in resin is severely restricted for applications with stringent viscosity requirement.

# Surface Modification For Enhancing Compatibility Of BN Platelets With Epoxy

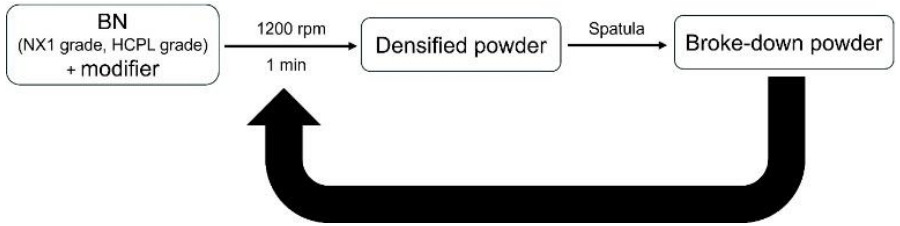
## Selected MT BN Platelet Grades for Surface Treatment

| Typical Physical Properties | NX1 | HCPL |
|---|---|---|
| Mean Particle Size µm | 0.9 | 10 |
| Surface Area $m^2/g$ | 20 | 7 |
| Tap Density $g/cm^3$ | 0.12 | 0.40 |
| Oxygen % | 1.00 | 0.40 |
| Soluble Borates % | 0.10 | 0.20 |



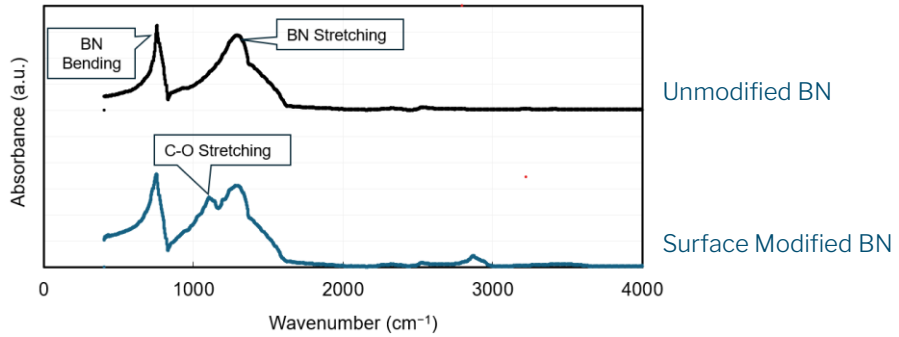




## Preparation



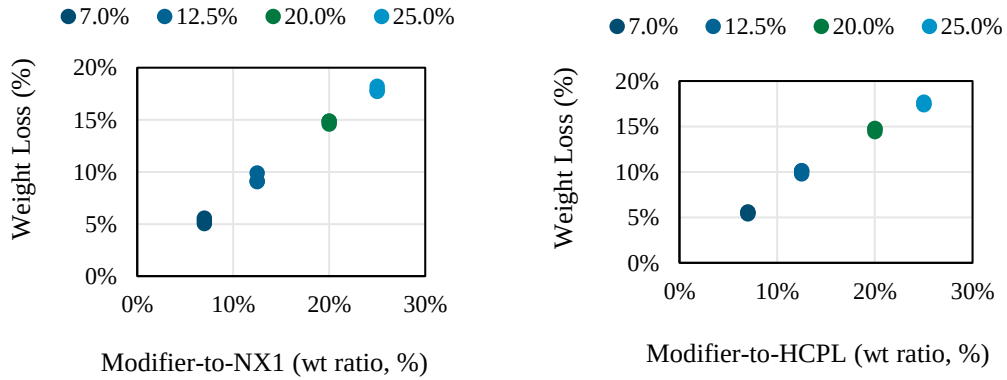

## Characterization of Surface Modified BN Platelets

### ATR-FTIR




Characteristic peak of surface treatment agent is identified on treated BN.

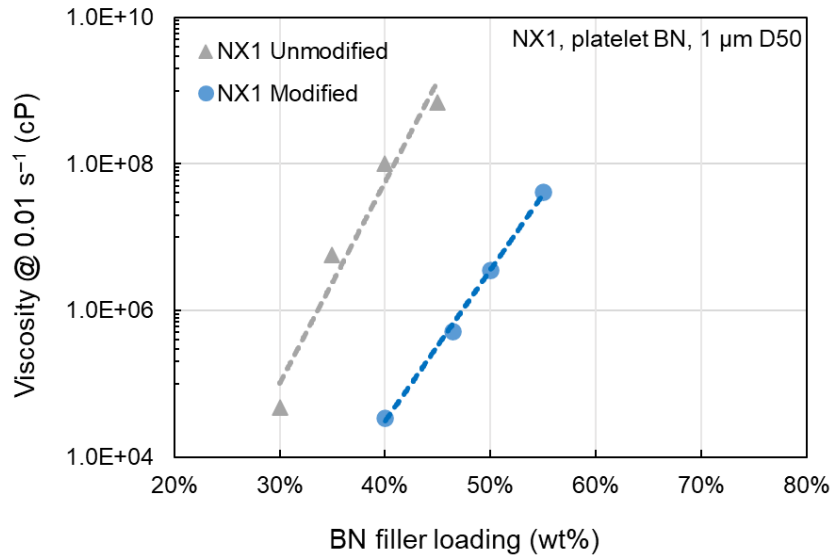
### TGA Weight Loss

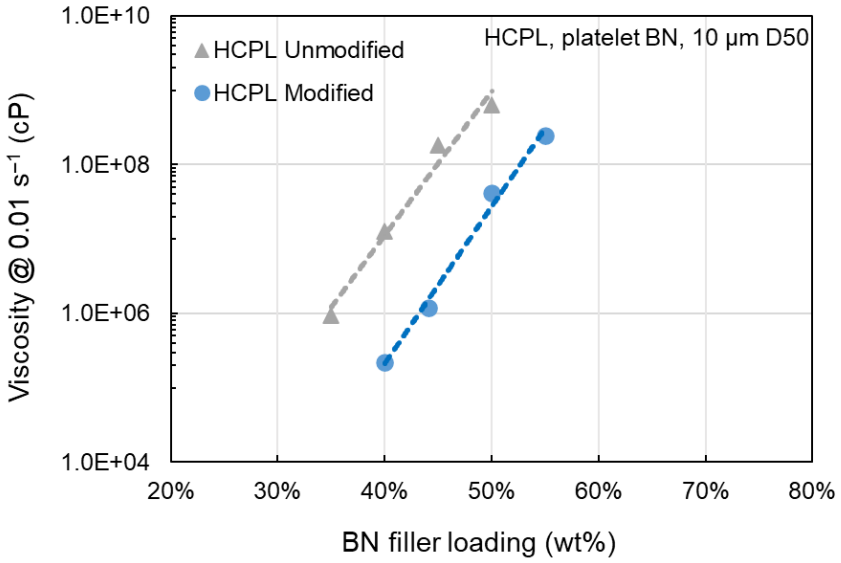



Surface treatment level is controllable.

**Controllable surface modification process has been established successfully for platelet BN powder.**

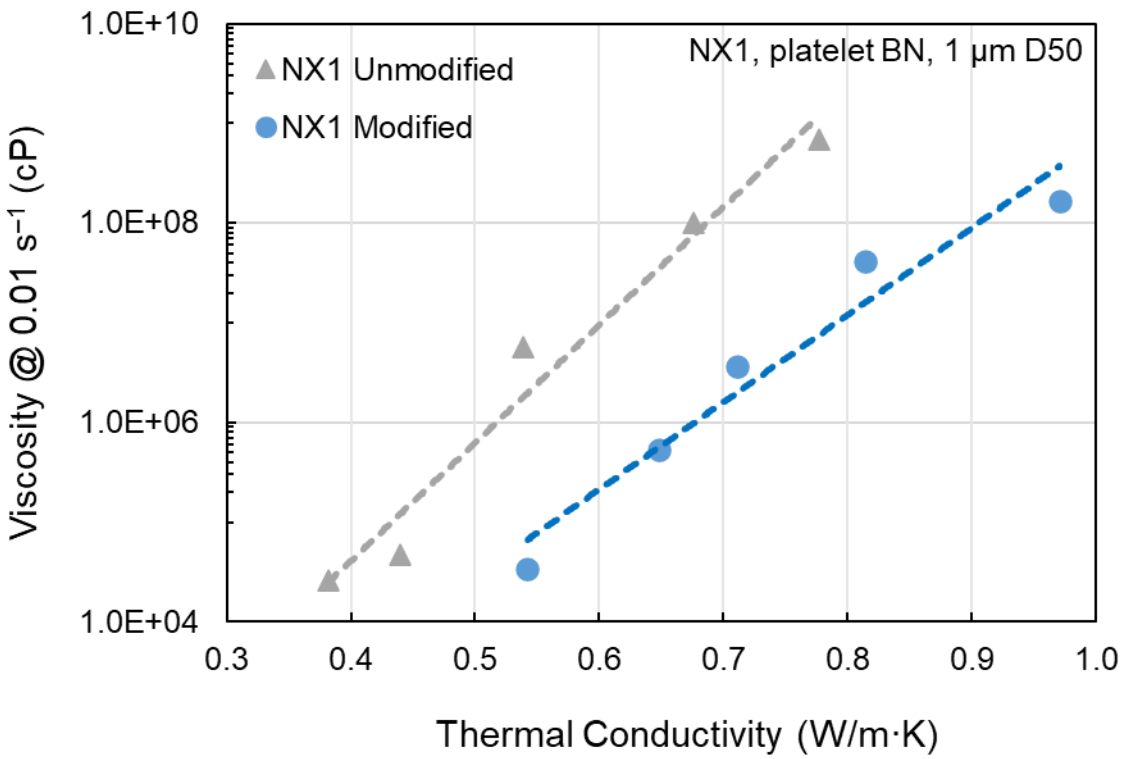
# Significant Viscosity Reduction with Modified BN

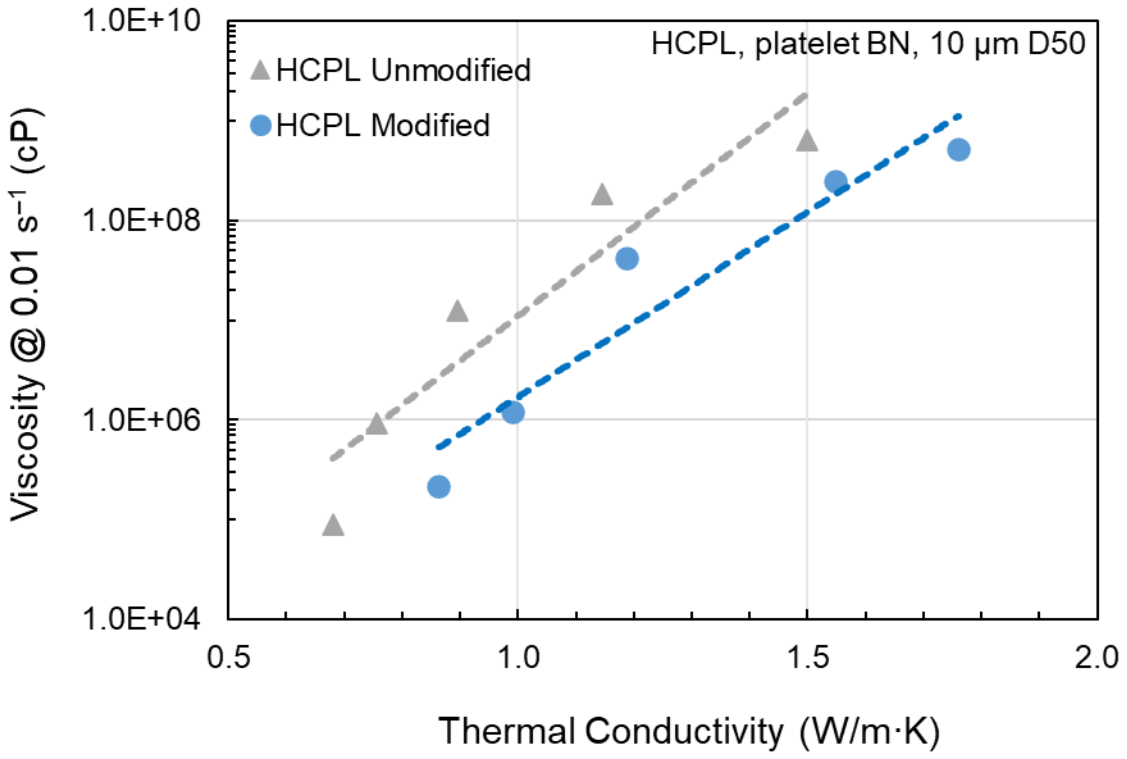



- Significantly improved compatibility with epoxy resin.
- Up to 2 orders of magnitude reduction in viscosity with same formulation.

# Epoxy Thermal Conductivity Improvement with Modified BN




>25% thermal conductivity improvement without impacting epoxy viscosity.

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# THANK YOU

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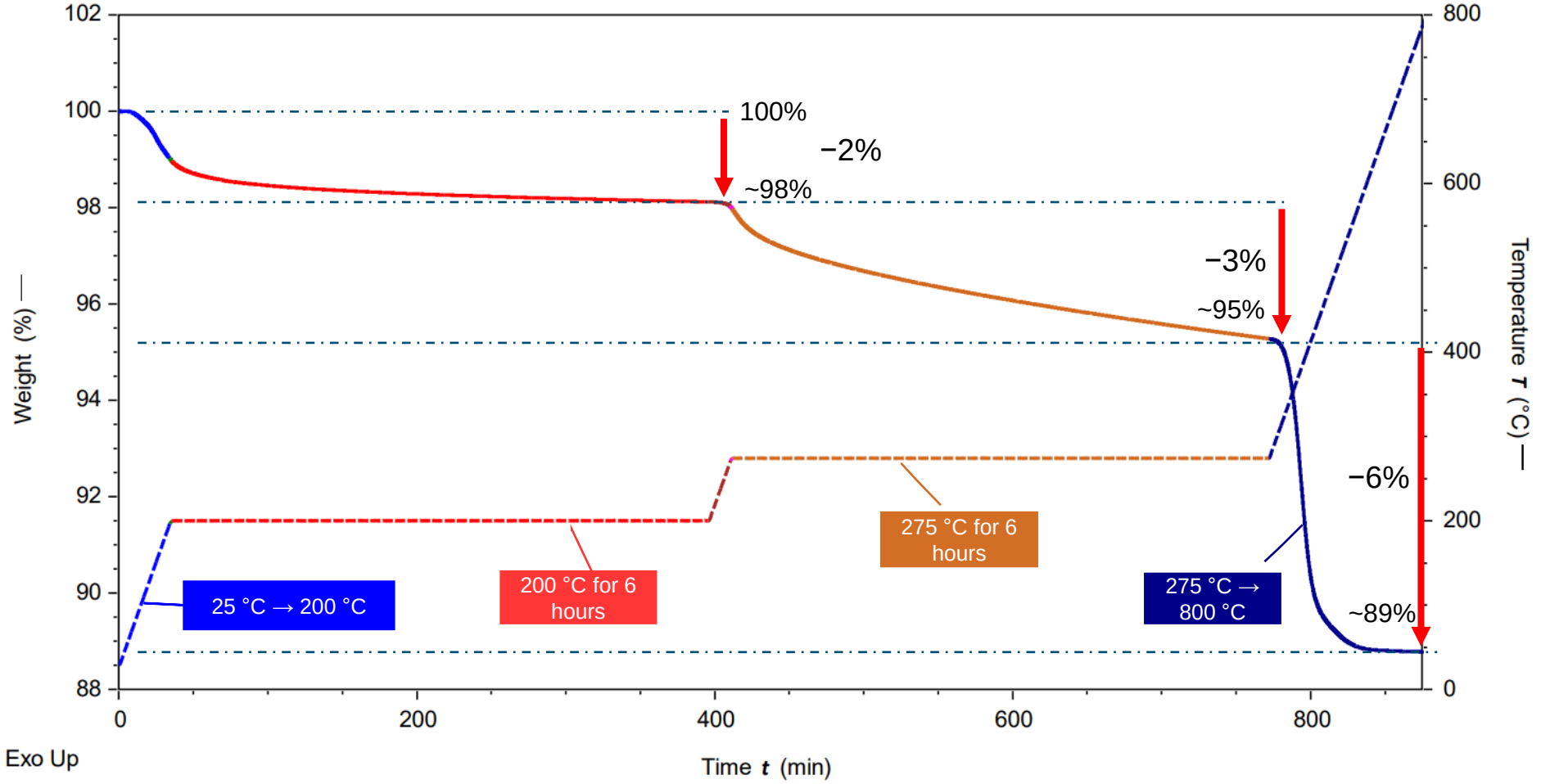
# Thermal Stability up to 200°C




6 parts of BN + 1 part of modifier

Surface functionality of treated BN is stable up to 200°C in inert gas.





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