Product Troubleshooting Guide
Phase Change Thermal Interface Materials

Phase Change Material (PCM) pads play a critical role in thermal interface applications, ensuring efficient heat transfer and temperature regulation in electronic components. However, during handling, storage, and application, various challenges may arise that can impact performance and reliability.

This Troubleshooting Guide aims to identify and address common issues encountered with PCM pads, including:

- Pad cut integrity concerns, analyzed through simulation tests at 40°C and 55°C over different time scales.
- Oil stain occurrence, which may affect material integrity and adhesion.
- Incomplete pad cuts, which can impact assembly efficiency.
- Pad thickness thinning down issues, where pads fail to thin down as expected under pressure.

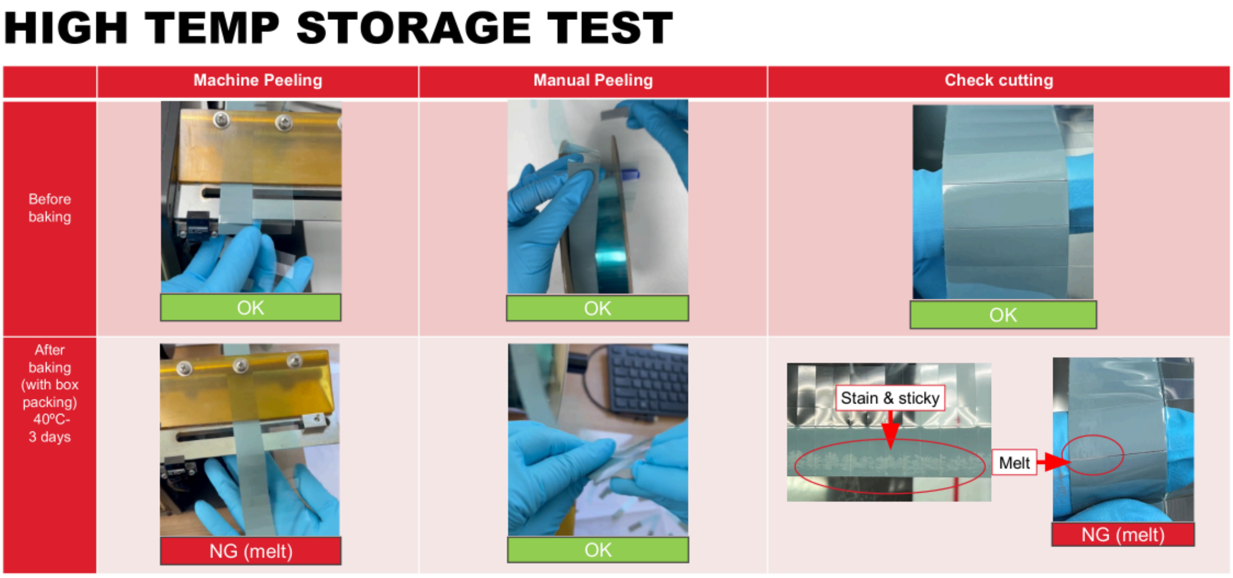
By understanding these challenges and their root causes, this guide provides practical solutions and best practices to optimize handling, storage, and application processes. Additionally, test results and observations are included to support data-driven troubleshooting.

For detailed recommendations and in-depth analysis, please refer to the CAPLINQ Honeywell Thermal Interface Material Pad Troubleshooting Guide sections that follow.

Thermal Simulation Test for Pad Cut Structure Integrity

40 ℃ High Temperature Simulation Test

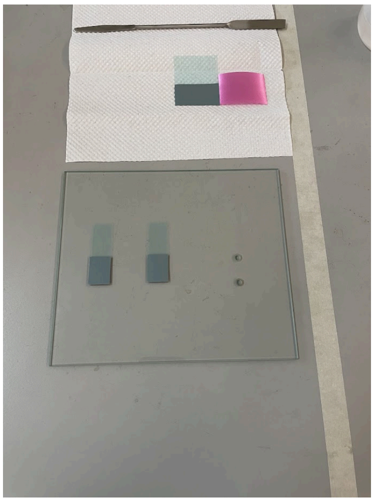
Description: Honeywell team have done a high temperature (40 ℃) exposure test on the pads in a span of three (3) days to check if the pads are still in good condition.

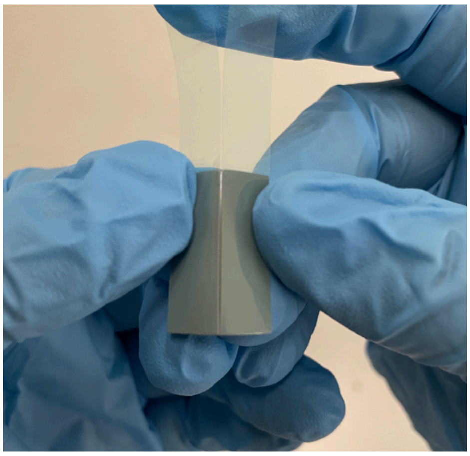


Observation: The baking test successfully replicated the melting and stickiness issue. However, during the manual peel test, the pads remained intact and were still suitable for manual peeling.

55°C High Temperature Simulation Testing

Description: The test aims to evaluate the material's stability at elevated temperatures and determine if melted pads remain workable after cooling. The test involves subjecting two interconnected pads to 55°C, monitoring their condition at specific time intervals up to 5 days. Finally, a manual peel test will be conducted to determine if the pads can still be handled effectively.

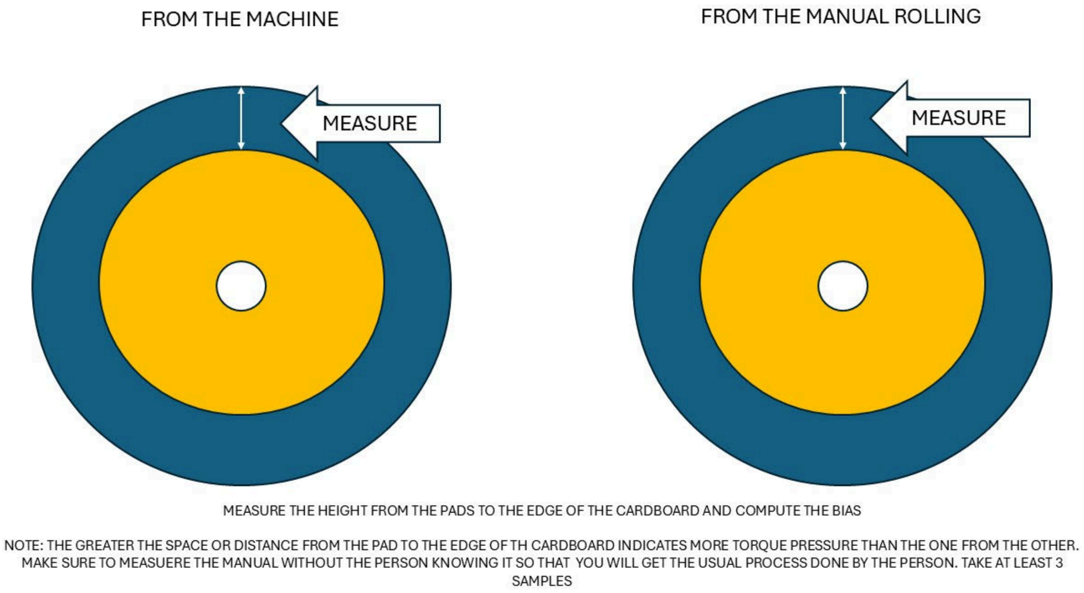



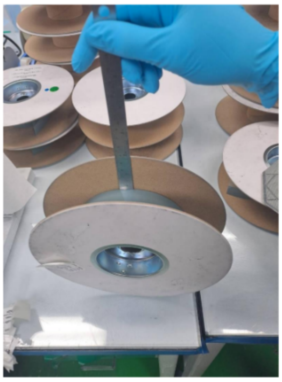



Observation: After five days of exposure in a 55°C oven, the pad cuts remained intact, and no oil stains were observed. The result is different compared to the previous 40°C in a roll since there is no load pressure to press the pads thus no sticky issues. **This test confirms that the occurrence of oil stains & melting on some pads is not temperature-related but rather caused by the tension load in reel form.**

Tension Load Test on Pad Reel

Description: The tension load test on the reel is conducted to determine and confirm whether torque pressure is the primary cause of oil stain. This test aims to validate the impact of compression during transport and assess potential mitigation strategies.





Roll No.	Before (cm)	After (cm)
	Machine	Inspection
1	4.6	4.6
2	4.6	4.6
3	4.6	4.6
4	4.6	4.6
5	4.6	4.6
6	4.6	4.6
7	4.6	4.6
8	4.6	4.6
9	4.5	4.5
10	4.6	4.6

Observation: Current study results indicate that oil bleeding occurs at a five-layer stack level. Since the reel exceeds this limit, there is a possibility of oil presence in the reel. However, Honeywell is currently conducting a packaging study to address this issue and explore possible solutions.

FTIR (Fourier Transform Infrared Spectroscopy) Oil-stained Pads

Description: We performed Fourier Transform Infrared (FTIR) spectroscopy to analyze both the oil-stained pads and fresh pads. This test will help confirm if the original components of the pads remain intact and have not undergone any chemical degradation during oil occurrence. By comparing the spectral data from the oil-stained pads to that of the fresh pads, we can ensure that the chemical composition has not been altered in a way that would negatively impact their performance, particularly with respect to adhesion and overall functionality

Laboratory results: FTIR results from the three (3) lots that we tested: one control (fresh pads) and QC1 & QC2 (Quality Complaint 1 & 2), which had experienced oil occurrence.

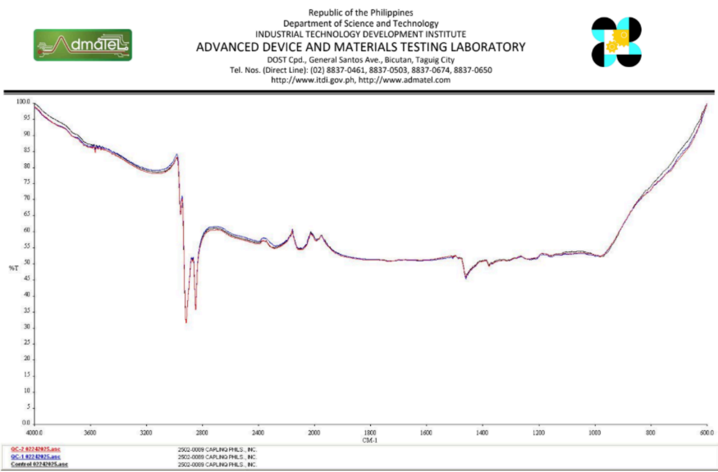
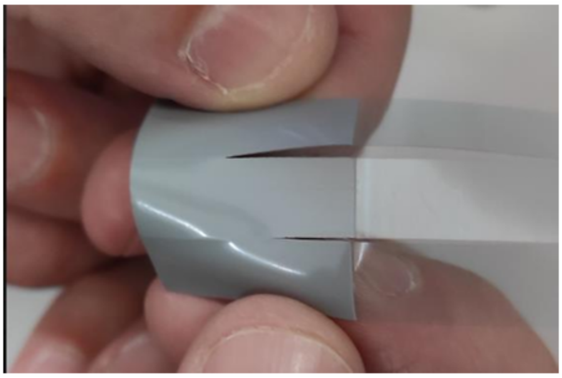
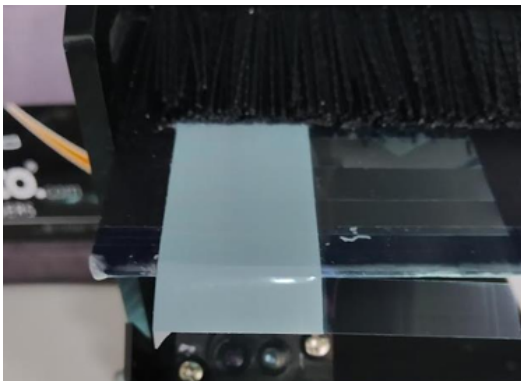


Figure 6. FTIR spectra overlap of: *Control Lot # H22T5011BA, QC-1 Lot # H22TUOG12A (UGC),* and *QC-2 Lot #H22T6CGIGB (5UC)*

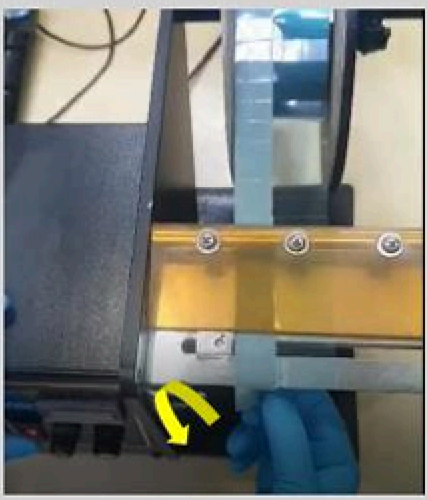
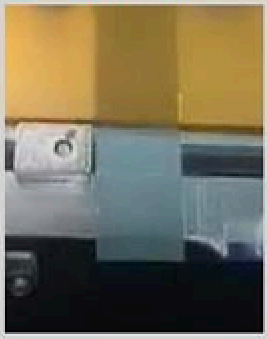
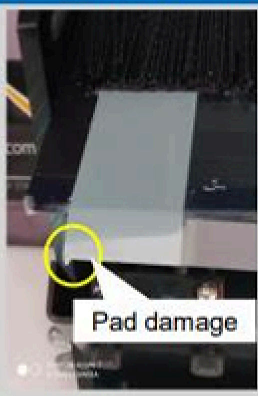
Based on the results, the infrared spectra of both the control and quality complaint samples are very similar, with only minor differences in peak frequencies, indicating that the initial materials are still present. Additionally, moisture peaks were observed in all three samples, confirming that the stain is not moisture-related.

Pad material is not fully cut Issue

Consequence: If not picked properly this will cause damage to the edge of the pad as shown.

Resolution: If encountered with an issue such as this, we recommend picking the pad down to prevent damage (See test image below for reference.)

Simulation test#1	Test result	Conclusion
Pick pad *down* while handling  OK method VDO	Result = OK Test result  Customer's information 	Pick pad *down* do not make pad damage

Case 2:

PTM7950 was not thinned down as usual Issue

(a) Storage condition for PTM7950 was targeted at customer side, so, customer shipped back 2 pcs of heatsink with PTM7950 and asked for HON's test support

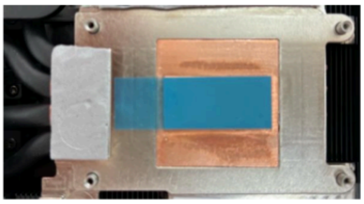


Figure 1: Heatsink 1, with PTM7950 on top

Figure 2: PTM7950 was removed from heatsink 1

PTM7950

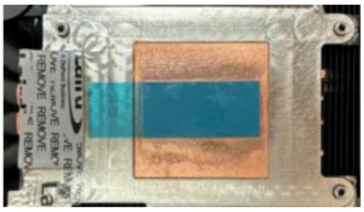


Figure 3: Heatsink 2, with PTM7950 on top

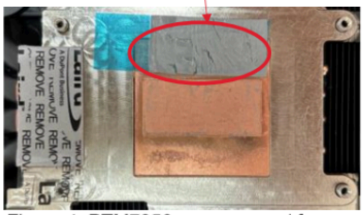
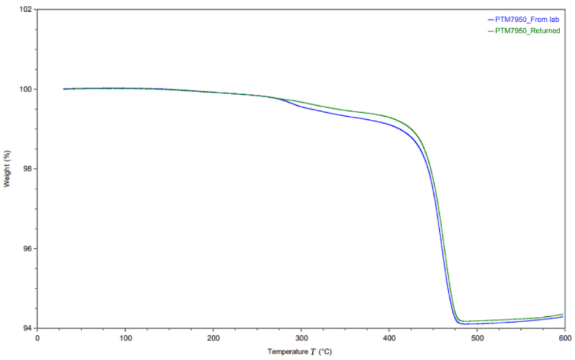


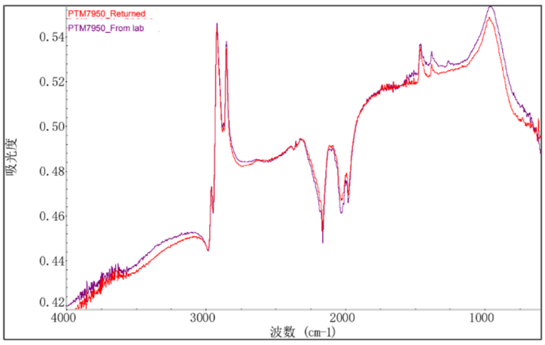
Figure 4: PTM7950 was removed from heatsink 2

(b) TGA and FTIR tests for returned samples were required. PTM7950 from HON lab was used in the TGA & FTIR test as parallel. Based on the laboratory test results, the peaks are similar between returned samples and fresh samples thus no material degradation was observed.

TEST RESULT OF TGA

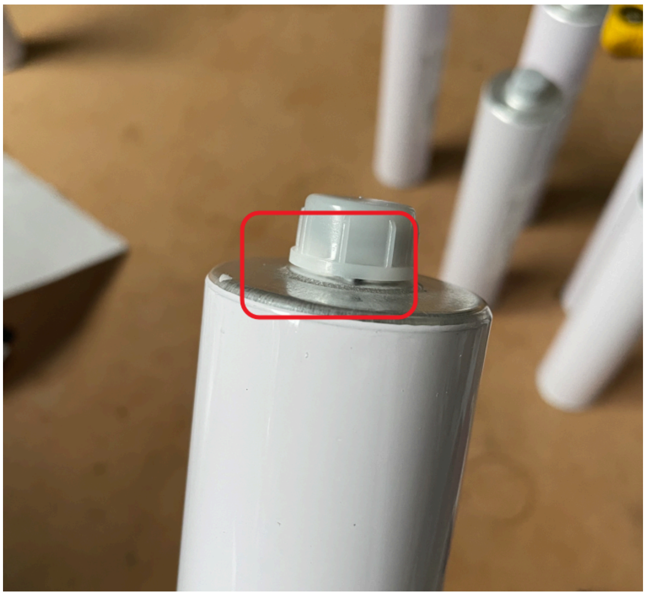


TEST RESULT OF FTIR



Damaged Cap & Minor Leak

The team encountered in one of the shipments minor signs of leaks due to damaged caps (See pictures below)



Recommendation:

Since the PCM paste material contains solvent, there is a high risk of evaporation and viscosity changes if the container cap is damaged. It is strongly recommended to replace the material to ensure consistent performance and reliability.

Case Study: Re-evaluating Expired PCM, When Is It Still Safe to Use

Currently, our Phase Change Materials (PCM) have a shelf life of up to 12 months under recommended storage conditions. However, there are instances where customers encounter expired stock beyond this period and inquire whether the material is still usable.

To support informed, data-driven decisions, Honeywell has conducted internal testing using retained samples beyond the shelf life stored at our manufacturing facility. The objective is to evaluate whether PCM materials beyond their stated shelf life still meet key performance criteria.

The following tests were performed:

- Thermal Impedance Testing (with and without shim), aligned with Certificate of Analysis (CoA) standards
- Viscosity Measurement to assess flow and printability
- Specific Gravity Testing to monitor composition consistency
- Moisture Content Analysis to check for degradation due to humidity exposure

These evaluations help determine whether the material remains within acceptable performance limits and can be conditionally approved for use in non-critical or internal applications.

We have identified the oldest Lots we have on hand:

Sample	Sample	Sample
H7SP30905A	**H7SP31114A**	**H7SP31115A**
2 months & 2 weeks expired	2 weeks expired	2 weeks expired

Table: Thermal Impedance & Viscosity

Lot	Retest TI with shim spec Max 0.25 °C cm2/watt	COA TI with shim spec Max 0.25 °C cm2/watt	Retest TI No shim spec Max 0.12 °C cm2/watt	COA TI No shim spec Max 0.12 °C cm2/watt	Retest Viscosity spec Max 100 Kcps@10RPM	COA Viscosity spec Max 100 Kcps@10RPM
H7SP30905A	0.153	0.108	0.046	0.056	84	83
H7SP31114A	0.138	0.131	0.052	0.047	81.5	75.5
H7SP31115A	0.146	0.148	0.051	0.033	84	80

Table: Moisture & Specific Gravity Test

Lot	Sample ID	Moisture (ug/g)	Density (g/cc)
1	*H7SP30905A*	*730.2*	*2.347*
2	*H7SP31114A*	*733.9*	*2.341*
3	*H7SP31115A*	*634.9*	*2.345*

Based on the Thermal Impedance retest, the results remained well within specifications when compared to the original values recorded in the Certificate of Analysis (CoA). In fact, the values were found to be nearly identical, indicating no significant degradation in thermal performance despite being beyond the 12-month shelf life.

However, some moisture was observed in the expired PCM material. This can be explained by the inherent properties of the material components:

The polymer matrix is non-polar and hydrophobic, meaning it naturally repels moisture.

The filler, on the other hand, is polar and hydrophilic, making it more prone to moisture absorption over time.
During extended storage, especially in less-than-ideal conditions, the filler may gradually absorb ambient moisture, which could affect consistency or long-term reliability depending on the application.

The data and observations provided are intended to support engineers in making technically informed decisions when evaluating the potential use of PCM materials beyond their specified shelf life. However, CAPLINQ and Honeywell do not guarantee product quality, reliability, or performance if expired materials are used in manufacturing processes. Use of such materials is at the customer's own risk, and any deviation from the recommended shelf life or storage conditions remains the sole responsibility of the end user.

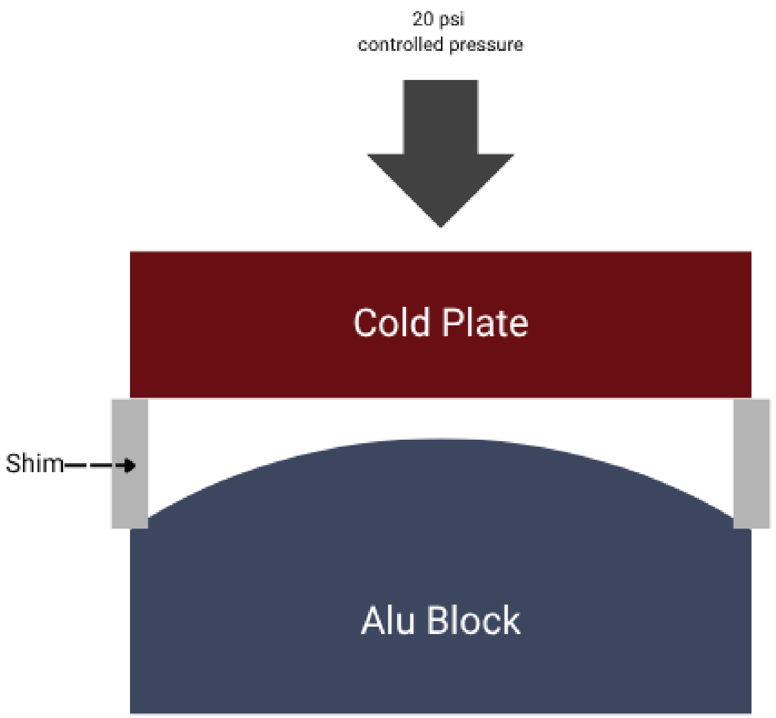
Case Study: Measuring Bond Line Thickness of Phase-Change Material with Non-Planar Substrate

Accurate bond line thickness (BLT) measurement is essential when validating the thermal performance of phase-change thermal interface materials (TIMs) such as PTM7950. However, obtaining reliable measurements becomes more challenging when the substrate includes curvature designed to replicate die warpage in real semiconductor packages.

This case study documents a customer's measurement issue, investigates the root causes of unexpected negative thickness readings, and presents a validated, repeatable method to characterize phase-change behavior on non-planar geometries.

Shim-Based Zeroing Method

To eliminate negative readings and stabilize the measurement reference, we recommended introducing a thin, non-compressible shim during the zeroing process.



Step 1: Zeroing With Shim

The shim is only used to establish the reference (zero).
Place the shim (typical thickness 25–50 µm) between the cold plate and the aluminum block without the TIM, then set the gauge to zero.
This ensures that “zero” corresponds to a small, known separation — not full metal contact.

Step 2 : TIM Measurement

Remove the shim and insert the TIM sample instead.
Run the test under the same load and temperature conditions.
The gauge now measures the true compression and thickness change of the TIM as the load and temperature are applied.
Because you already know the shim thickness (25 - 50 µm), you can correct your absolute thickness values by that known offset if needed.

This set-up prevents false negative readings caused by fixture expansion or micro-deformation at a metal-to-metal interface.
The shim is not part of the actual test, it’s removed before measurement, so it does not interfere with the TIM’s phase change or the final bond-line thickness reading.

Additional notes for this set-up:

Shim material that can be used are thin stainless shim or Kapton/Polyimide shim works well. Choose something stiff and non-compressible at the forces you use.
Verify with a control: after zeroing with shim, remove shim and run a “no TIM” control (only metal-metal at test load) while heating to 60 °C to quantify thermal/fixture drift.

This helps separate true TIM compression/flow from fixture expansion.
For data correction, subtract the shim thickness from final steady-state displacement if you want absolute bond-line thickness referenced to true metal contact.

Optimizing Thermal Paste Application on Non-Planar Surfaces

When working with curved or non-planar substrates, gravity and surface tension behave differently compared to flat surfaces. This can significantly influence how thermal interface materials (TIMs) spread and adhere, affecting overall thermal performance.

To address this, researchers and engineers have explored advanced techniques to better control paste distribution on complex geometries. One such method is interfacial structuring, which involves texturing the substrate with micro-scale features such as grooves, ridges, or pillar-like patterns. These microstructures increase the effective surface area, helping the TIM to spread more uniformly while improving retention.

This approach has already seen successful application in the field. For example, some power module manufacturers implement micro-groove designs to enhance thermal surface contact and reduce pump-out issues during thermal cycling, leading to more reliable and efficient thermal management.

By leveraging such surface engineering techniques, thermal performance can be optimized even on challenging curved substrates, ensuring long-term stability and efficiency.