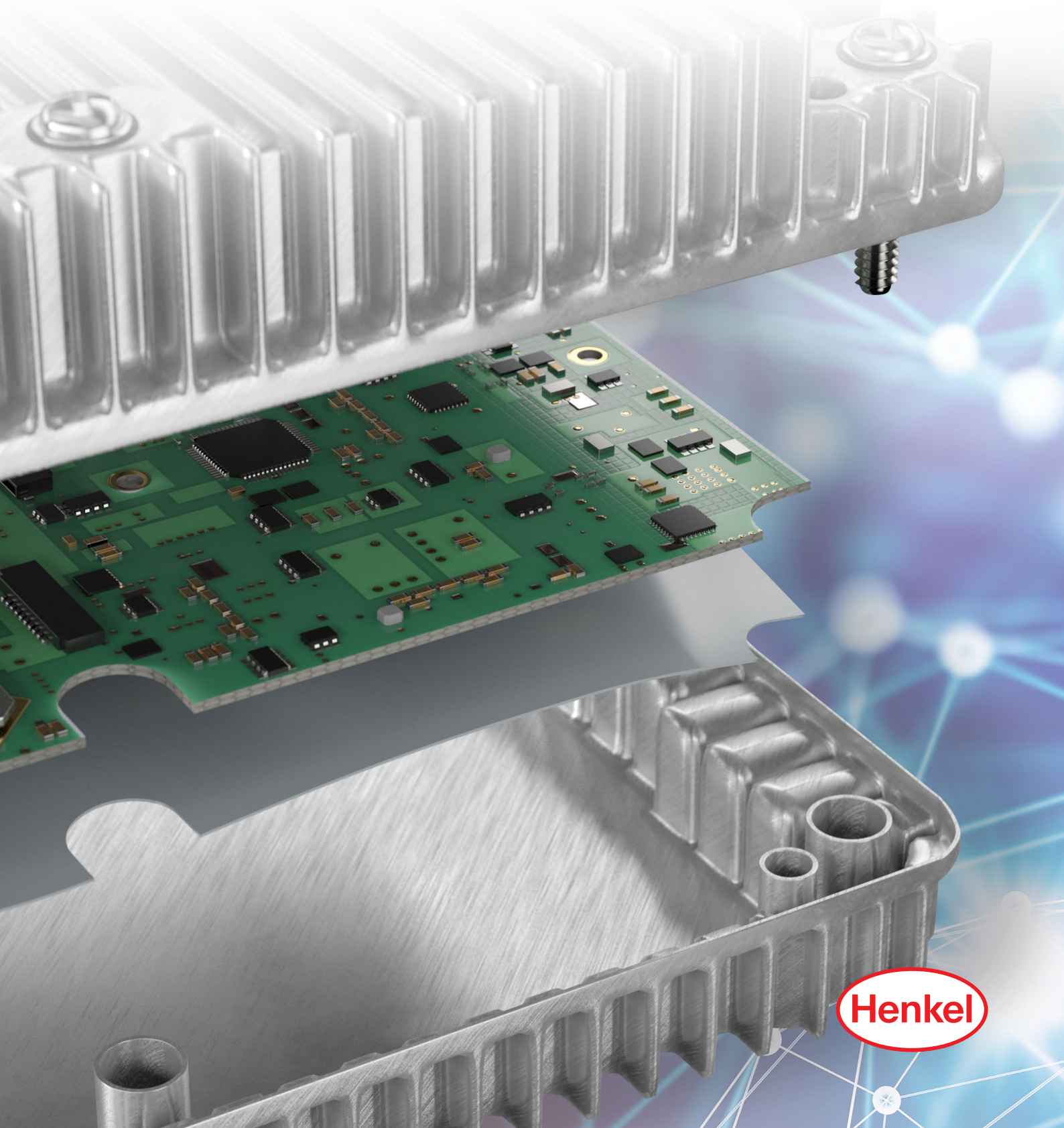
LOCTITE®

Assembly Film
Troubleshooting Guide



Henkel

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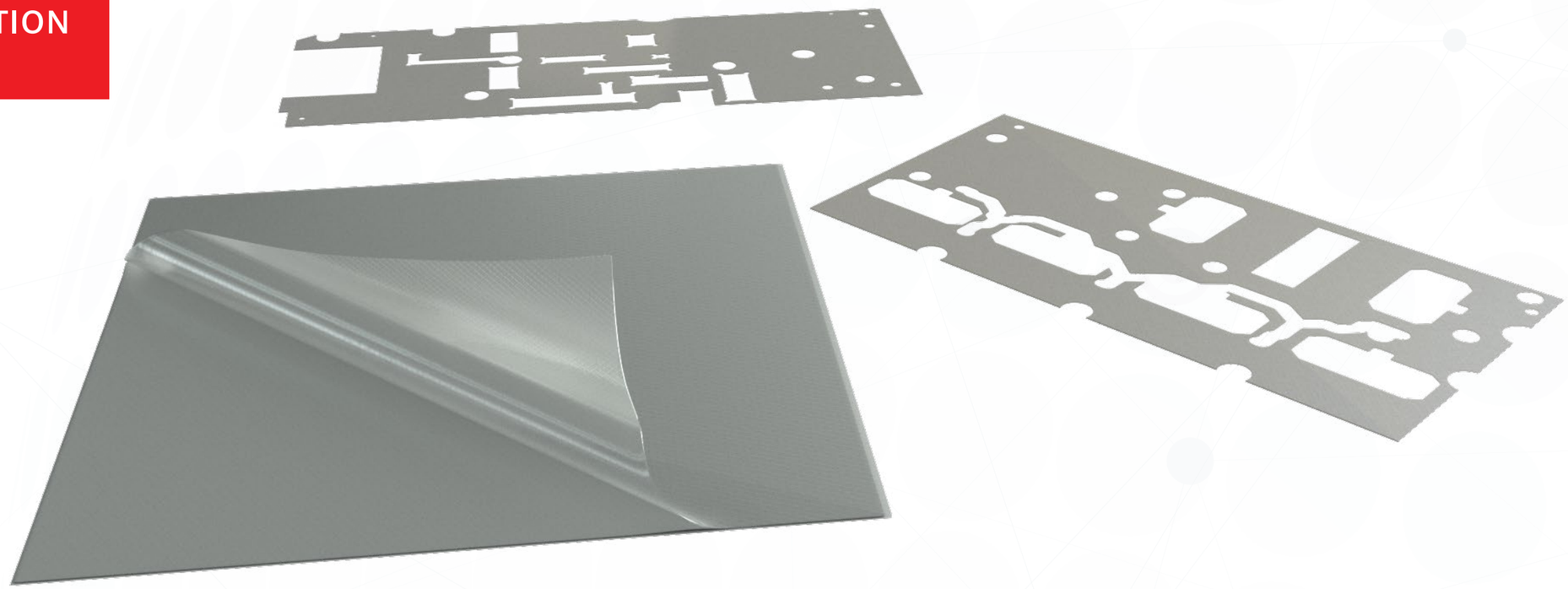


SEE MORE

- NASA outgassing sellsheet
- Assembly film video
- Satellite teardown video

Henkel has more than 40 years of experience supplying quality adhesives for high reliability **applications designed for aircraft, unmanned aerial vehicles (UAV),** ground and maritime vehicles, **satellites, guidance systems, radar,** sonar and homeland security with LOCTITE®, TECHNOMELT® and BERGQUIST® product solutions.

We are **qualified and specified by all major aerospace OEMs** and contractors, supporting our products through a worldwide sales, applications engineering, research and development and manufacturing network. Our state-of-the-art products, certification to major aerospace specifications, and technical expertise ensure that products built with Henkel electronic assembly materials will be the highest in performance and in reliability. We are committed to meeting and exceeding your requirements with:

- NASA outgassing ASTM E 595-77/84/90 approved products
- Proven film and paste technology in aerospace applications
- Custom film pre-form manufacturing capability
- Low-risk supply chain

ASSEMBLY FILM: PROVIDING HIGHEST RELIABILITY PERFORMANCE

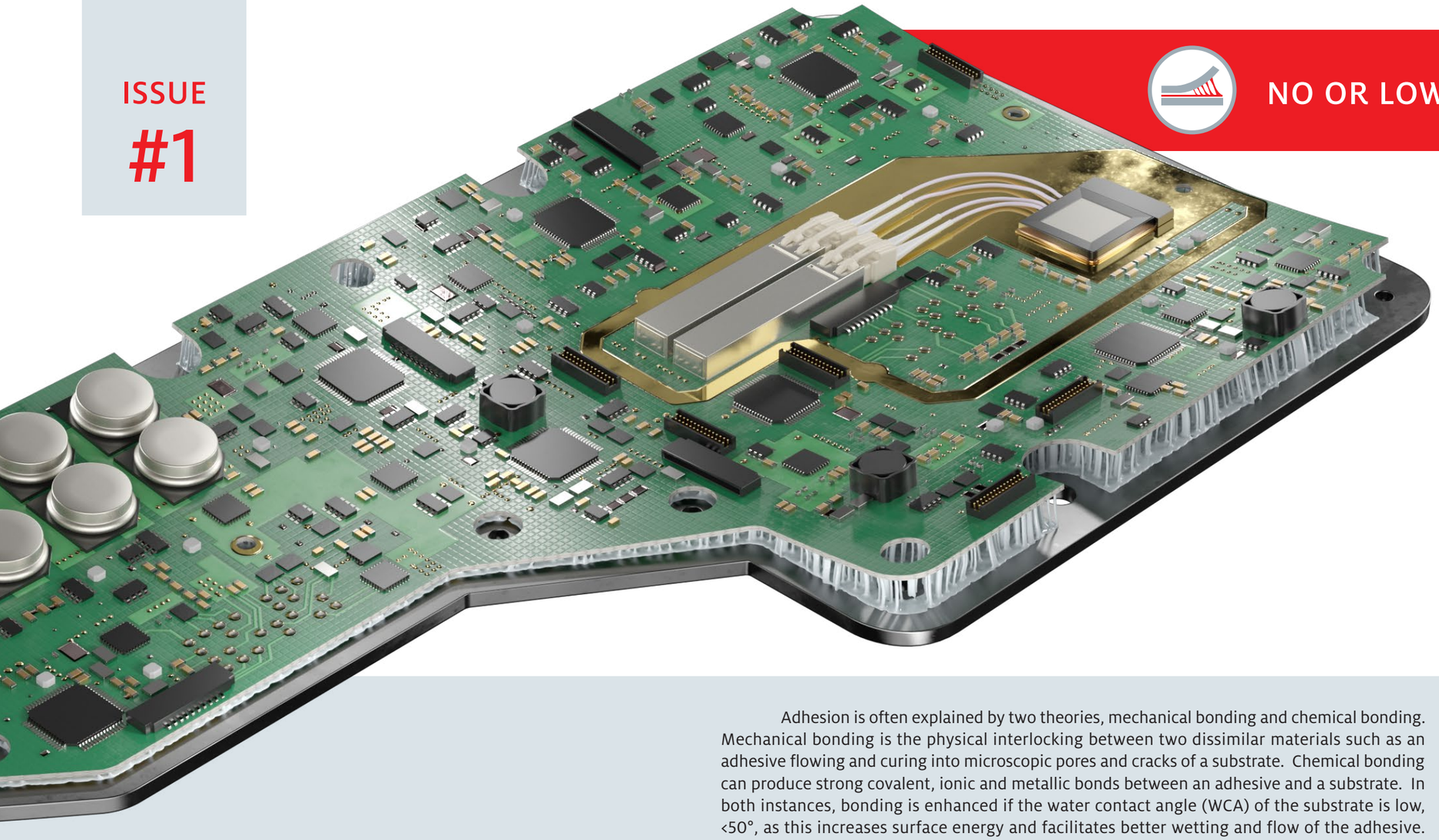
With increasing functionality and power requirements for electronic equipment, the need for thermal management is critical. Henkel's assembly films not only provide best-in-class electrical, thermal, and mechanical performance, but also lower total assembly costs through the elimination of inventory maintenance and/or third-party conversion. We provide **custom cut film preforms to precisely match highly-complex printed circuit board shapes and patterns.** This ensures an exact amount of void-free adhesive with a controlled bondline thickness in a specific area.

ISSUES, ROOT CAUSES AND CORRECTIVE ACTIONS OVERVIEW

ISSUE	ROOT CAUSE	CORRECTIVE ACTION
Issue #1: **No or low adhesion**	Didn't remove Mylar™ protective liner	Remove Mylar™ and green poly liner
	Improper substrate surface preparation	Optimize surface preparation
	Curing process	Optimize the cure process
	Film shelf life expired	Use a new piece of film
Issue #2: **Excessive flow or resin bleed**	Too much pressure	Decrease pressure
	Improper substrate surface preparation	Optimize surface preparation
	Wrong film being used or film thickness	Revisit assembly film or consider a different film
	Curing process	Optimize the cure process
Issue #3: **Parts are moving during cure**	Pre-tack process has not been optimized or used	Recheck pre-tack for time, temperature & pressure or use a pre-tack process
	Curing process	Optimize the cure process
	Incorrect film being used	Consider using an alternative film or different thickness
	Improper substrate surface preparation	Optimize surface preparation
Issue #4: **Warping of substrates**	Substrate is out-of-spec	Review substrate vendor specifications
	Assembly film is too thin	Use thicker assembly film
	Curing process	Optimize the cure process
	CTE mismatch causes parts to warp	Incorrect film for application
Issue #5: **Delamination after cure**	Curing process	Optimize the cure process
	Pressure being applied unevenly	Evaluate various methods to apply even pressure
	Film storage/work life expired	Obtain fresh film
	Air voids in film layer causing uneven adhesion	Try hot tacking or using a vacuum bag/autoclave to reduce entrapped air
	Improper substrate surface preparation	Optimize surface preparation
Issue #6: **Film seems hard or brittle and isn't tacky anymore**	Film has passed it maximum storage life	Obtain fresh material
	Film was improperly stored	Check storage conditions
	Film was left out in ambient temperature too long	Improve assembly procedure to prevent extra film from being left out
	Film was exposed to heat prior to use	Check storage conditions
Issue #7: **Conductivity is poor or decreasing**	Film is delaminating	See "no/low adhesion" section
	Excessive high temperatures exposure	Reduce reflow temps or assemble application after the reflow process
	Metallization or solder mask is not compatible with the film	Use substrates that have a compatible metallization
	Poor adhesion	See "no/low adhesion" section

Click around for more information!

ISSUE
#1



NO OR LOW ADHESION

Adhesion is often explained by two theories, mechanical bonding and chemical bonding. Mechanical bonding is the physical interlocking between two dissimilar materials such as an adhesive flowing and curing into microscopic pores and cracks of a substrate. Chemical bonding can produce strong covalent, ionic and metallic bonds between an adhesive and a substrate. In both instances, bonding is enhanced if the water contact angle (WCA) of the substrate is low, <50°, as this increases surface energy and facilitates better wetting and flow of the adhesive.

One of the most common root causes of poor adhesion are insufficiently conditioned and controlled substrates resulting in a high WCA above 50°. A simple solvent wipe of the substrate many times remedies the adhesion issue but sometimes other techniques such as mechanical or chemical abrasion are required. One should also examine the entire substrate supply chain preparation, storage and handling and consider implementing controls at each step to ensure consistency.

Processing steps of the assembly film that should be examined to potential identify a root cause of an adhesion issue include ensuring appropriate cure time, temperature and pressure were achieved during cure. Sometimes additional time in the oven is required for full cure if parts are large to compensate for the longer temperature ramp up time. Thermal couples are recommended to exactly track the oven temperature profile. If too much pressure was used during cure, that can lead to squeezing adhesive out which minimizes adhesive available to bond while too little pressure may not be sufficient to adjoin adhesive to the substrate.

NO OR LOW ADHESION

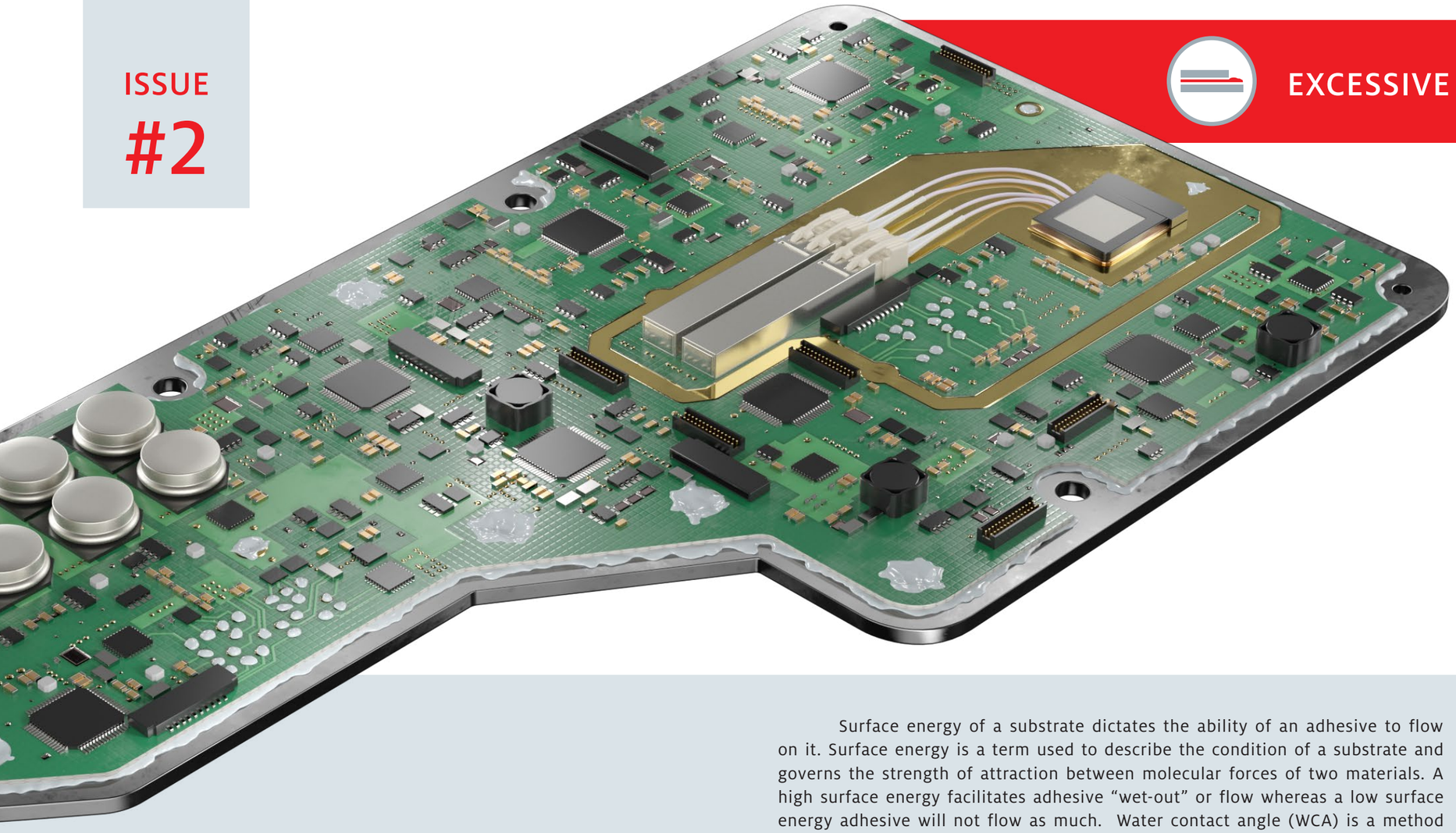
ROOT CAUSE

1. Didn't remove Mylar™ or accidentally used green poly liner.
2. Substrate not prepared properly or cleaned prior to cure.
3. Film not fully cured.
4. Not enough pressure.
5. Film shelf life expired.
6. Film left out beyond work life.

CORRECTIVE ACTION

1. Remove Mylar™ and green poly liner.
2. Reclean substrates
   Check for contaminants in cleaning solution
   Be sure substrate contact angle is <50˚.
3. Check oven temperature using thermocouples including at the bondline of film adhesive. Make sure parts see correct temp for entire cure time. Try a longer cure time if necessary.
4. Use a better pressure application method, or increase pressure if low. Refer to Henkel cure pressure guide.
5. Use a new piece of film that is within shelf life.
6. Use fresh film with its entire work life remaining.

ISSUE
#2



EXCESSIVE FLOW OR RESIN BLEED

Surface energy of a substrate dictates the ability of an adhesive to flow on it. Surface energy is a term used to describe the condition of a substrate and governs the strength of attraction between molecular forces of two materials. A high surface energy facilitates adhesive “wet-out” or flow whereas a low surface energy adhesive will not flow as much. Water contact angle (WCA) is a method to determine the relative surface energy of a substrate and industry standard recommendation of <50° is ideal for sufficient flow leading to good adhesion.

A common cause of an assembly film flowing too much is a low WCA indicating an excessively high surface energy of the substrate. Optimization and control of the substrate supply chain including preparation, storage and handling is critical for consistent substrate surface conditions.

Another common root cause of excessive flow of an assembly film is too much pressure was used during the cure. Too much pressure will squeeze out the adhesive causing it to flow.

Some assembly films due to their formulation tend to flow more than other assembly films. Sometimes flow is a desirable characteristic while other times flow is undesirable. Matching the correct assembly film to the application requirements regarding flow is critical.

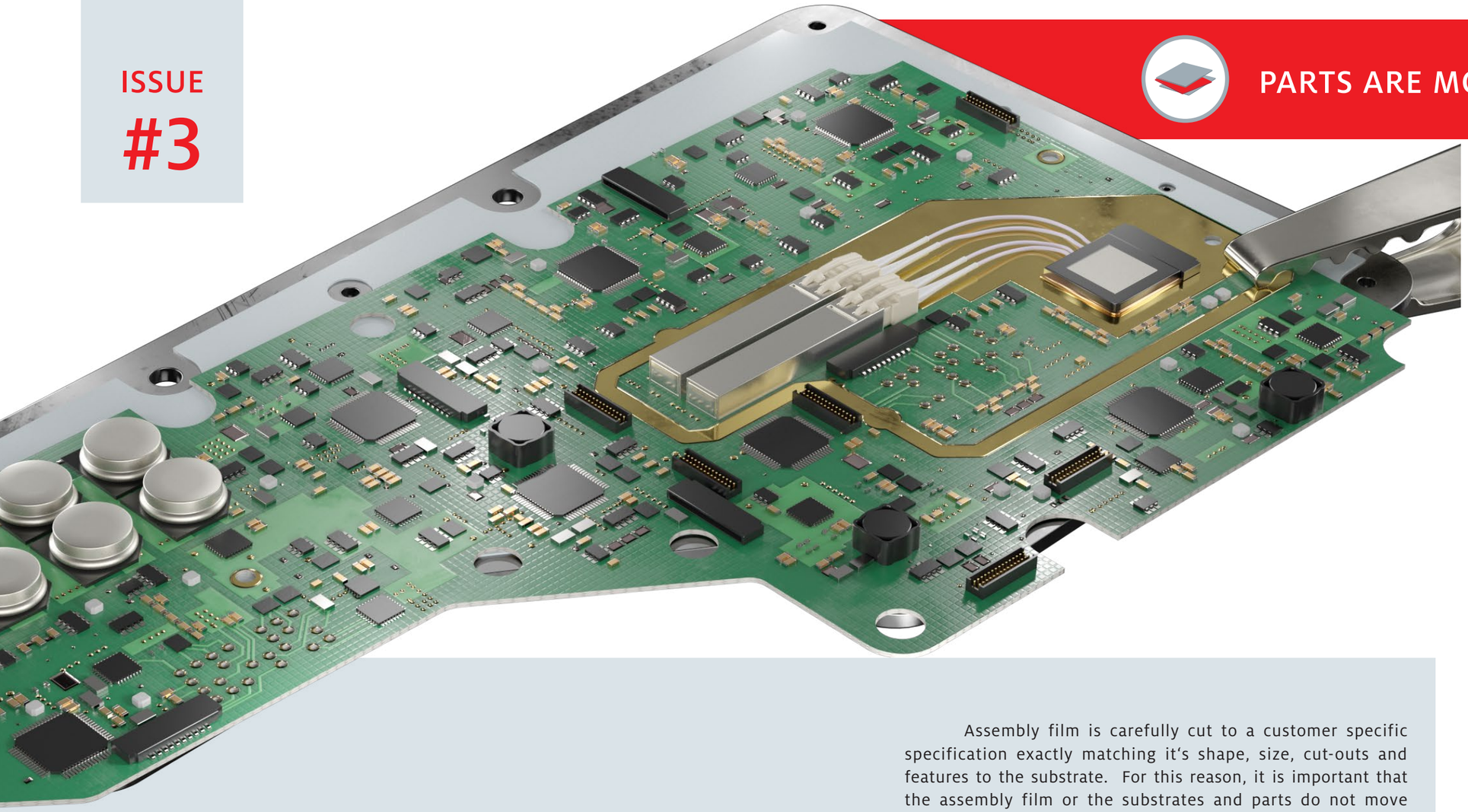
ROOT CAUSE

1. Too much pressure.
2. Substrate not prepared properly or cleaned prior to cure.
3. Wrong film being used.
4. Cure conditions not optimized.

CORRECTIVE ACTION

1. Decrease pressure. Refer to Henkel cure pressure guide. Consider an alternative pressure method.
2. Reclean substrates.
   Check for contaminants in cleaning solution.
   Be sure substrate contact angle is <50˚.
3. Revisit assembly film selection.
4. Revisit cure temperature & time guidelines.
   Refer to Henkel cure pressure guide.

ISSUE
#3



PARTS ARE MOVING DURING CURE

Assembly film is carefully cut to a customer specific specification exactly matching it's shape, size, cut-outs and features to the substrate. For this reason, it is important that the assembly film or the substrates and parts do not move as it is being cured and bonded. A pretack can be utilized to make the assembly film slightly tacky which will help it stick to the substrate and not move during the cure cycle.

Other common root causes of parts moving during cure include insufficient pressure being applied during cure. Assembly film requires pressure during the cure to attain a well formed bondline and preventing parts from moving.

Inadequate preparation of the substrate can have a big impact on the ability of the film adhesive to wet and bond. Ideal water contact angle is 25-°50° . This ensures adequate adhesive flow to maximize adhesion but not too much flow which can lead to undesirable results.

PARTS ARE MOVING DURING CURE

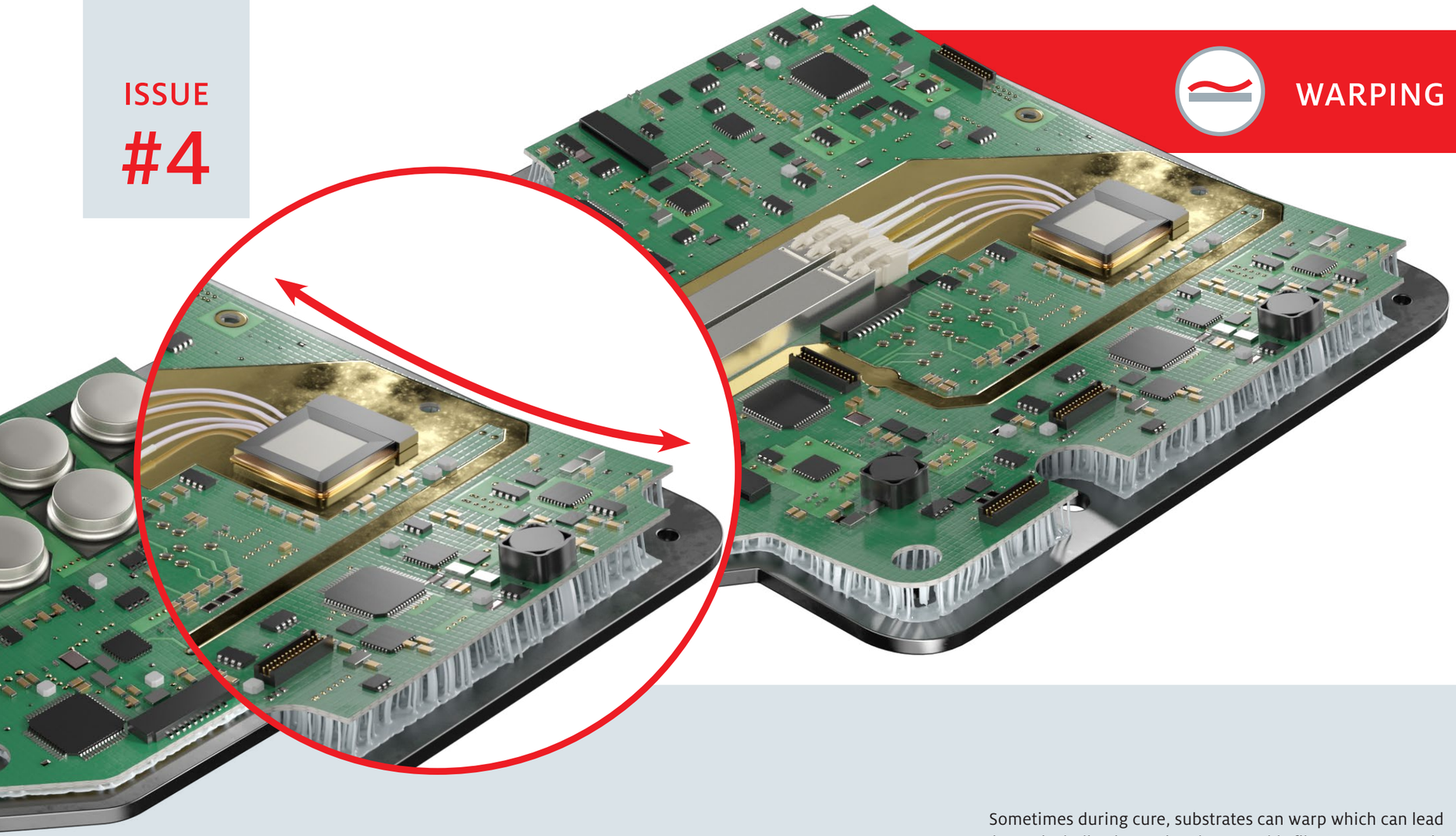
ROOT CAUSE

1. The pre-tack process has not been optimized.
2. A pre-tack process is not being used.
3. Insufficent pressure being applied dueing cure.
4. Incorrect film being used.
5. Substrates not prepared & cleaned appropriately.

CORRECTIVE ACTION

1. Recheck pre-tack for time, temperature & pressure.
2. If a pre-tack process is not used, consider using one.
3. Refer to Henkel cure pressure guide.
   Consider increasing pressure.
   Consider alternative method of applying pressure.
4. Consider using an alternative film or different thickness.
5. Surface energy is too low. Consider abrading surface of substrates, solvent clean or chemical treatment.

ISSUE
#4



WARPING OF SUBSTRATES

Sometimes during cure, substrates can warp which can lead to many issues including impacting the assembly film to cure properly and failed components and parts. Larger substrates are probably more likely to warp than smaller substrates. Also, large CTE (coefficient of thermal expansion) mismatches may lead to inherent stresses and warping as well as thin substrates or out-of-spec substrates.

To compensate for these inherent and unavoidable challenges with substrates, using a thicker assembly film can sometimes be the corrective action. Assembly films can be ordered in thicker sizes or consider laminating two assembly film layers together. Also, depending on the application, a lower modulus assembly film will be more forgiving with large CTE mismatches.

WARPING OF SUBSTRATES

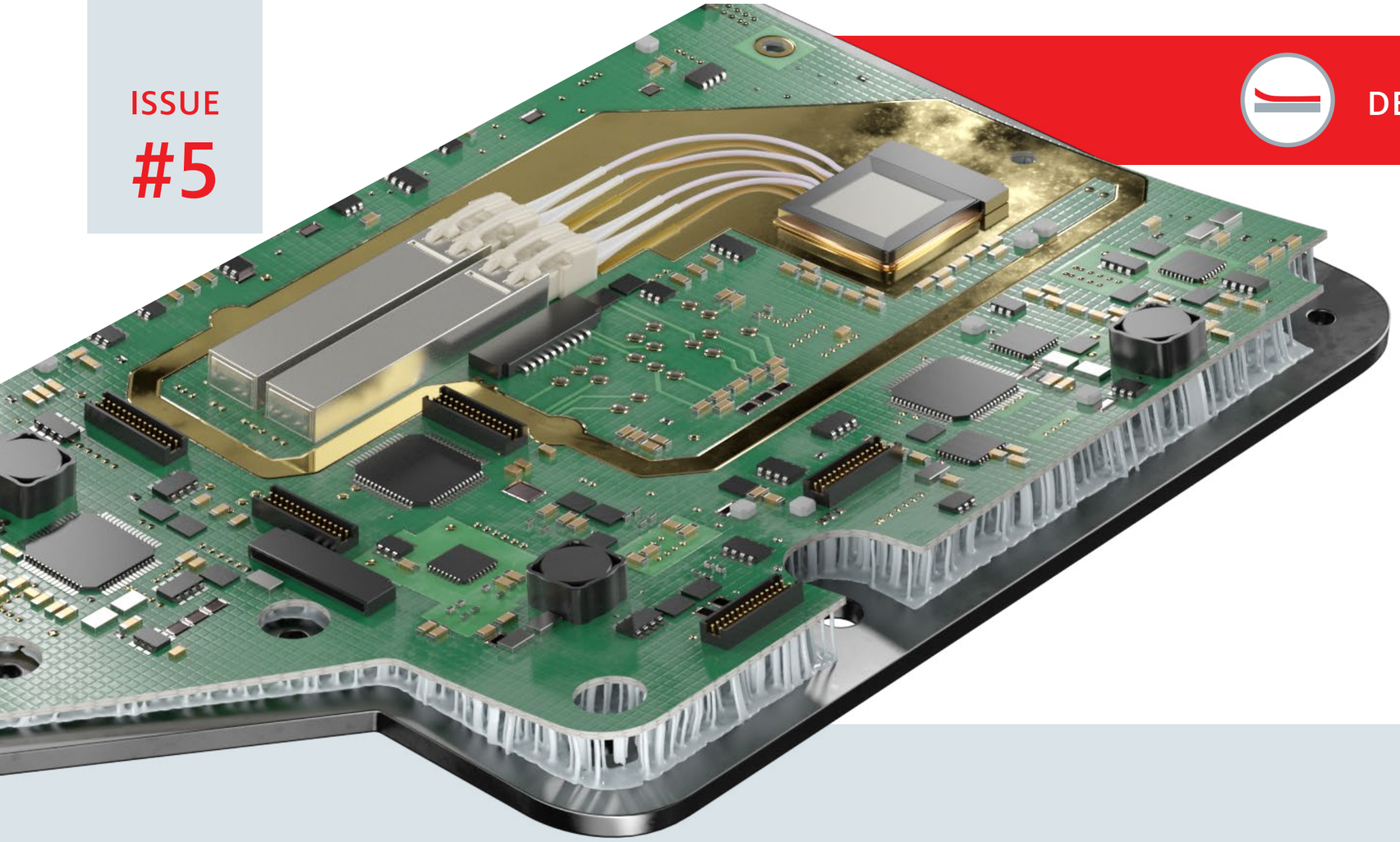
ROOT CAUSE

1. Substrate is out-of-spec.
2. Too thin an assembly film is being used.
3. Cure process is not optimized.
4. CTE mismatch causes parts to warp.

CORRECTIVE ACTION

1. Review substrate vendor specifications for storage and handling guidelines.
2. Use thicker assembly film, consider using two layers of film.
3. Revisit cure temperature & time guidelines. Refer to Henkel cure pressure guide.
4. Incorrect film for application, recommend a lower modulus assembly film.

ISSUE
#5



DELAMINATION AFTER CURE

Delamination is a mode of failure where a material fractures into two layers. If this occurs in an electronic assembly including assembly film, typically it is an adhesive failure mode at the adhesive-substrate interface where the assembly film pulls away from the substrate. Common causes of this include poorly prepared substrates which require cleaning. Other common causes include issues with the assembly film curing process such as not enough pressure being applied or the film was not fully cured.

If air was entrapped between the assembly film and substrate as the assembly film was being placed down, that may lead to adhesion issues such as delamination as well.

DELAMINATION AFTER CURE

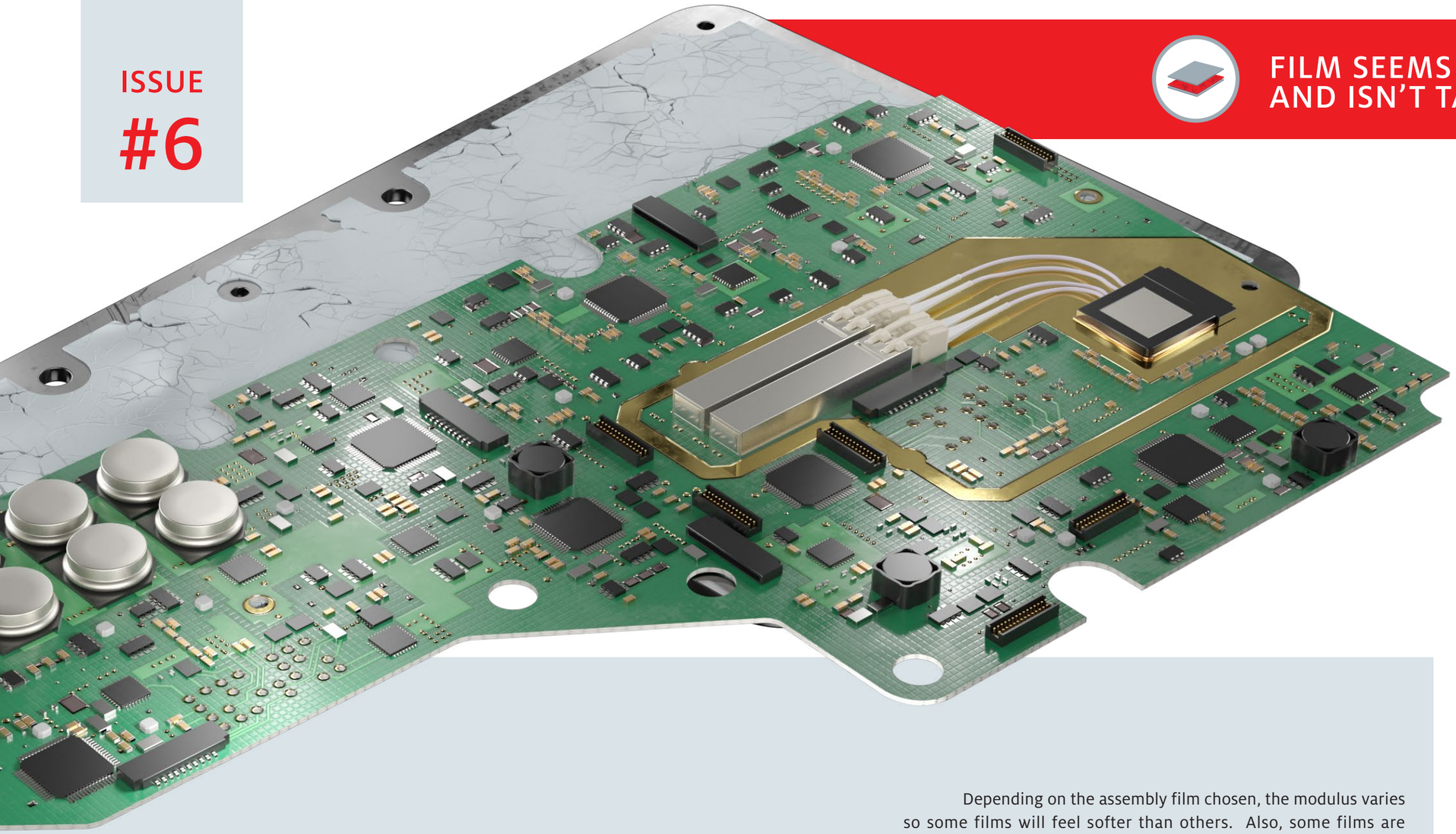
ROOT CAUSE

1. Not enough cure pressure.
2. Film not fully cured.
3. Pressure being applied unevenly.
4. Film storage/work life expired.
5. Air voids in film layer causing uneven adhesion.
6. Poor cleanliness.

CORRECTIVE ACTION

1. Raise cure pressure to obtain better wet-out.
2. Check cure process including temperature, time and pressure. Check that parts are at required temperature for given time.
3. Evaluate various methods to better apply even pressure. If vacuum is used, support rim of board so it is not being pinched.
4. Get fresh film.
5. Try hot tacking or using a vacuum bag/autoclave to reduce entrapped air.
6. Reclean substrates.
7. Check for contaminants in cleaning solution.
8. Be sure substrate contact angle is <50˚.

ISSUE
#6



BRITTLE ASSEMBLY FILM

FILM SEEMS HARD OR BRITTLE AND ISN'T TACKY ANYMORE

Depending on the assembly film chosen, the modulus varies so some films will feel softer than others. Also, some films are manufactured with a carrier which will make it feel stiffer while others do not have a carrier. Regardless of the hardness of the film due to modulus or carrier, the assembly film in an uncured state should not be extremely hard, dried and brittle. In fact, some films are even tacky in an uncured state.

If an assembly film seems very hard and brittle prior to use, common causes include the film was not stored properly, was left out at ambient temperature or has passed its maximum storage life. Assembly film requires cold storage to maintain its stability.

ROOT CAUSE

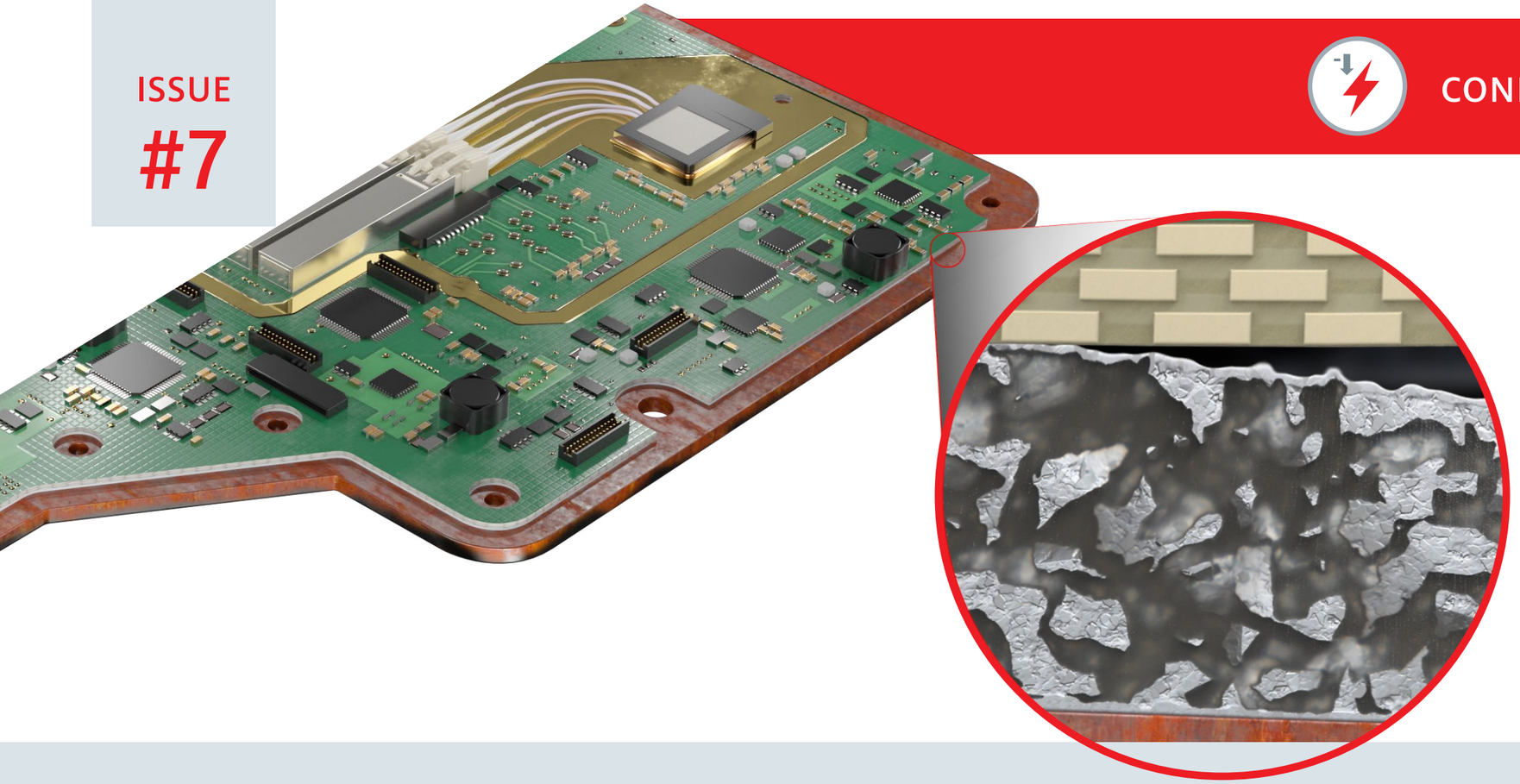
1. Film has passes it maximum storage life.
2. Film was improperly stored.
3. Film was left out in ambient temperature too long.
4. Film was exposed to heat prior to use.

CORRECTIVE ACTION

1. Obtain fresh sample.
2. Check storage conditions with those recommended. Storing at a higher temperature can shorten life of film.
3. Improve assembly procedure to prevent extra film from being left out.
4. Check storage conditions with those recommended. Storing at a higher temperature can shorten life of film.

ISSUE

#7



CONDUCTIVITY IS POOR OR DECREASING

Electrical and thermal conductivity is achieved by adhesive filler particle to particle contact and good wetting and bonding at the adhesive-substrate interface. Filler used in conductive adhesives is commonly silver but sometimes other conductive metals are used such as gold, copper or nickel.

If an application using assembly film is experiencing poor conductivity or the conductivity is changing with time, this is indicative of issues of the film delaminating from the substrate, poor adhesion or not fully cured. A conductive path needs to be maintained from one substrate, through the assembly film and onto the second substrate. A delaminated surface interferes with this continuity and breaks the conductive path.

CONDUCTIVITY IS POOR OR DECREASING

ROOT CAUSE

1. Film is delaminating.
2. Film is being exposed to excessively high temperatures (ex: solder reflow).
3. Improper substrate materials are being used.
4. Poor adhesion.

CORRECTIVE ACTION

1. See “Delamination” section.
2. Film can not handle solder reflow, reduce reflow temps or assemble application after the reflow process.
3. Use substrates that have excellent stability and conductivity (ex: gold plated, alodined, ENIG plated aluminum; treated copper, or silver substrate).
4. See “Poor Adhesion” section.

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