

Carrier tape for lead-free assembly of FPCBs

Generally, flexible printed circuit boards (FPCBs) have been fixed on a carrier plate (jig) using single-sided polyimide film tape, film-based double-sided tape or resin-coated carrier plate, but these types of holding methods produce inconvenience and problems.

Tacsil[®], a reusable FPCB carrier tape, has longer service life (repeating use cycle > 500 times at normal SMT solder reflow process), fewer open and short problems, less amount of solder non-wetting, easy cleaning, easy fixing and easy removal. It offers more flexibility the design of the carriers, because it can be cut or die-cut according to your carrier board designs. Also, the adhesion level of surface can be controlled for customer's requirement. Tacsil[®] increases productivity, saves costs and increases yield. Technical information and guidelines will be described in detail in this paper.

Y.M.Lim, *managing director and*
K.Y.Park, *technical manager,*
Korea Taconic. Co. LTD

Keywords:
FPCB, SMT, Tacsil,
Carrier Plate, Silicone
Compound

Introduction

Structure

Tacsil[®] is composed of five layers of materials (Figure 1).

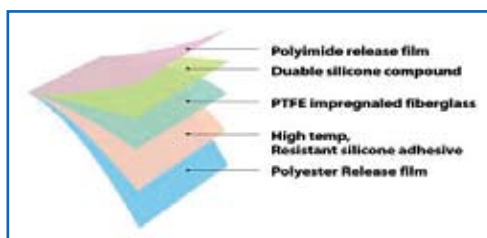


Figure 1. Tacsil[®] structure.

- PTFE (PolyTetraFluoroEthylene) impregnated fiberglass is used as a substrate, reinforcing materials. It offers highly credible dimensional stability at high temperatures, up to 260°.
- The side of Tacsil[®] that is to be attached to the carrier plate is composed of silicone adhesive specially modified for continuous use in FPCB application that leaves no adhesive residues at most lead-free SMT temperatures.
- The other side, to be attached on FPCB, is composed of well-balanced silicone compound to maintain adhesion properties during the repeating usage. Tacsil[®] tape can be used in over 500 cycles at normal SMT process.
- A PET & PI film liner on both sides protects and maintains performance without any contamination and makes die-cutting easier.

Main application

Tacsil[®] makes it easy to attach and fix FPCBs and thin rigid PCBs to carrier plates. It can be used with temperatures up to 260° and will endure more than 500 cycles. Moreover, it is easy to cut to fit your FPCB shape and equipment circumstance. Tacsil[®] is suitable for:

- SMT process of flexible printed circuit board
- SMT process of thin rigid PCB
- Carrier of LCD assembly process
- Flip chip mounting process
- Various temporary fixing applications

Comparison with conventional method

FPCB Assembly - PI(Polyimide) Tapes

FPCBs have commonly been affixed to metal plates using single-sided polyimide film tapes (Figures 2 and 3). This type of holding method produces lots of inconvenience:

- Difficult to hold the whole surface in case of the high density SMT or COF fixing process.
- Printing accuracy is not good.
- Impossible to reuse of PI tapes, cost increase.
- Low workability and productivity due to PI tape replacement each time.
- Adhesive residue remains after PI tape has been removed.



Figure 2. Polyimide (PI) tape.

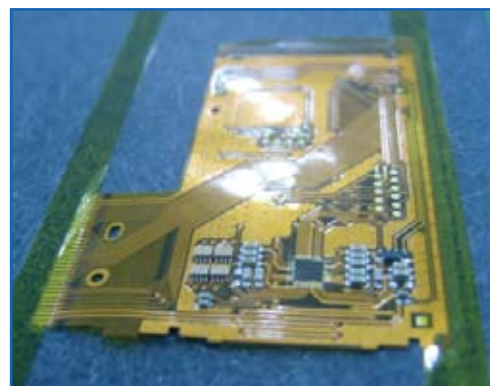


Figure 3. Application of PI tape.

FPCB Assembly - Resin coated carrier board

Some carrier plate manufacturers use resin-coated plates (Figure 4), which can be reused, but this method has its own inconveniences.

- Customer's choice to select a plate material is impossible.
- Impossible to remove resin from board after used up.
- High cost.
- Resin thickness deviation may induce unstable fixing.

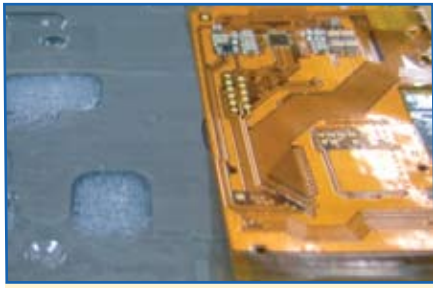


Figure 4. Resin-coated carrier board with FPCB.

FPCB Assembly - Film base double side tapes

Double-side tapes with silicone adhesives have also been tried for FPCB carrier fixing (Figure 5), but they too have their weak points:

- Too strong bond between FPCB and tape and damage the products.
- Substrate materials including polyimide film do not perform credible dimensional stability in repeated high temperature applications.
- Too much flexible substrate causes folding or wrinkling problems.
- Decomposed adhesive residue may remain on FPCB.
- Problems of solder non-wetting by low-molecular-weight silicone polymer.



Figure 5. Film-based double-sided tape.

Advantages of Tacsil®

Tacsil® has a number of benefits for FPCB assembly, such as:

- Excellent dimensional stability at high temperature (no distortion, shrinkage or expansion at 250°, continuing usage condition).
- Superior adhesion and holding power of silicone adhesive.
- No adhesive residues after removal.
- Longer lifetime of silicone compound side, allowing it to withstand more than 500 cycles under normal SMT conditions.
- Easy cleaning using Ethanol allows extension of lifetime.

- Good surface flatness allows the whole area of FPCB to be fixed.
- Adhesion level of silicone compound can be controlled - low, moderate, high - for customer's requirement.
- Excellent cut & die-cut properties.
- No PI tapes required (cost reduction and workability).
- Easy fixing and easy removal.
- Allows flexibility in carrier design.

Properties

Typical values of Tacsil®

Tacsil® allows the customer to select the best adhesion level of silicone compound for his application. Tacsil® properties are shown in Table 1.

Table 1. Properties of Tacsil®.

Tacsil® Type	Thickness* (mm) Silicone compound/ substrate / PSA**	180° Peel Adhesion (N/25mm) on SUS PSA/Silicone compound	180° Peel Adhesion (N/25mm) of PI film on silicone compound surface (R.T***./After 250C)	Holding Power (PSA side, 2.2psi @ 260°... x 2hr)	Tensile strength (N/50mm)
TacsilF20-H	0.07 / 0.08 / 0.05	> 7 / 0.4	0.4±0.05 / 0.4	No creep,	AF > 500
TacsilF20	0.07 / 0.08 / 0.05	> 7 / 0.3	0.3±0.05 / 0.3	No creep,	AF > 500
Tacsil F20-M	0.07/0.08/0.05	> 7 / 0.15	0.15±0.05 / 0.15	No creep,	AF > 500
TacsilF20-L	0.07 / 0.08 / 0.05	> 7 / 0.1	0.1±0.05 / 0.1	No creep,	AF > 500
Tacsil F10H	0.04 / 0.02/0.035	> 7 / 0.4	0.4±0.05 / 0.4	No creep,	AF > 200

* : Tacsil® F20 thickness 0.2mm is designed based on the assumption that carrier plates has 0.1mm deep slot to put the Tacsil® on it and 0.1mm height of Tacsil® on top of the level of carrier plate, is good enough to have precise solder printing afterward. Tacsil® F10, which is 0.1mm thick is designed to put directly on flat carrier surface without slots.
 ** PSA : Pressure Sensitive Adhesive *** R.T : Room Temperature **** Tacsil® F10H : Development stage product

Information on the volatile silicone level at silicone compound side.

As you know, silicone contains volatile, low molecular weight polydimethylsiloxanes that can cause contact failures, especially the D4 to D9 species, which constitute what is known as the 'total silicone volatiles.' The D4 to D9 molecules in the silicone adhesive used in Tacsil® are always controlled to around 200 ppm (Tables 2 and 3).

Table 2. D4 to D9 species in Tacsil® silicone adhesives.

Species	Tacsil® F20	Tacsil® F20-L
D4 to D7	210 ppm	160 ppm
D4 to D9	220 ppm	180 ppm

Test method by GC(Gas Chromatography)
 Sample :1.0g / acetone 10ml / n-undecane 2 ul
 GC conditions
 Column temp. 40 degrees C (1min) -320 degrees C (50min) at 15 degrees C /min
 Inlet 250 degrees C , splitless mode.
 Detector FID, 320 degrees C
 Column DB-5M 30m x 0.25mm x 0.25 micron film

How to use

Application procedure

1. Carefully cut or die-cut according to your carrier board design using cutting machines like a fodder chopper or die-cutting M/C for sharp edge trim.
2. Clean the surface of carrier boards with alcohol and then pre-heat the carriers.
3. Peel off the protection film of the adhesive side (PSA side) with care.
4. Attach the adhesive side of Tacsil® to boards using your hands and then a rubber roller for uniform bonding
5. Peel off the protection film of the silicone compound side. You must wear dust-free gloves during application. (Don't peel off the protection film before

use or the silicone compound surface will become contaminated by oil or dust)

6. Put the FPCB on the silicone compound surface by hand. In the case of rigid PCBs, a rubber roller may be used for firm fixation.
7. Porous surface materials, like composite materials (Durostone®/CDM) and anodized aluminum, need pre-aging to kick out entrapped air and humidity.

Table 3. Boiling points of D4 to D9 species.

Species	Boiling Points
D4 - Octamethyltetracyclosiloxane	176°
D5 - Decamethylpentacyclosiloxane	211°
D6 - Dodecamethylhexacyclosiloxane	245°
D7 - Tetradecamethylheptacyclosiloxane	276°
D8 - Hexadecamethyloctacyclosiloxane	303°
D9 - Octadecamethylnonacyclosiloxane	326°

Cautions for usage

Cleaning

If you find the adhesion level of silicone compound side is decreased by the surface contaminations, wash the surface with

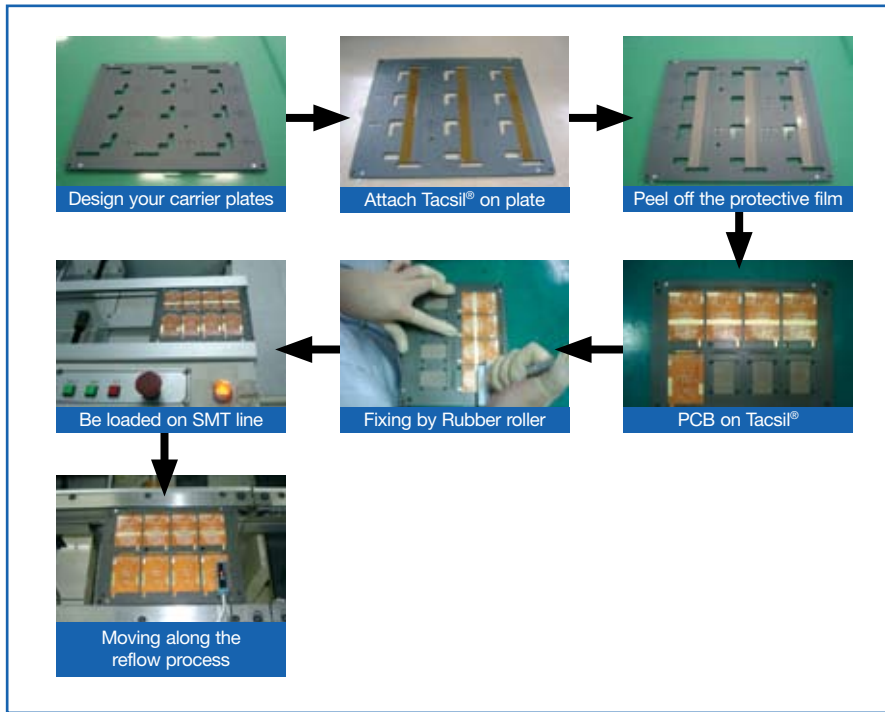


Figure 6. Step by step application process.



Figure 9. FR-5. Needs no pre-aging.

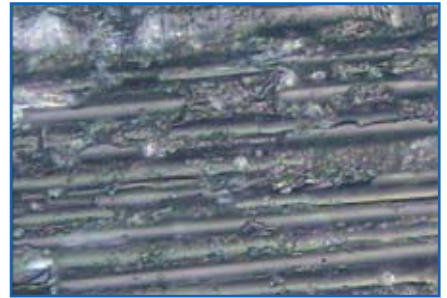


Figure 10. Durostone composite. Pre-aging required.

alcoholic to recover adhesion. (Ethanol is recommended.)

Cautions for various carrier materials

- If you use aluminum (except for aluminum with anodized surface (porous)) or metal board as carrier boards (Figures 7 & 8), you can apply Tacsil® directly on boards.
- If you use FR-4/FR-5 bakelite (Figure 9), you can apply Tacsil® directly on boards unless it contains high humidity.
- If you use Durostone/CDM board (Figure 10) or aluminum with a porous, anodized surface (Figure 11), it is strongly recommended that you pre-age the board before applying Tacsil® to remove entrapped air.

Pre-aging instructions: Before attaching Tacsil®, pass the Durostone/CDM through your SMT reflow chamber either with a temperature profile up to 255°C one to three times or with a temperature profile around 200°C for over five minutes. Then, for best performance, apply Tacsil® just before Durostone has cooled to room temperature.

The pre-aging process will help you prevent bubble problems during the SMT process, and the performance of Tacsil® will last longer. If a bubble occurs after the reflow process, press on the bubbles with a rubber roller. No further bubbles should occur.

Figures 7 through Figure 11 show the surfaces of various carrier panels at a magnification of 500X.

Tack control

There are two main ways to control the tack between an FPCB and Tacsil®. One is to choose the tack level of Tacsil® and the latter is to adjust the area to contact. As a general rule, we recommend the following:

- Single layer FPCB or thinner ones

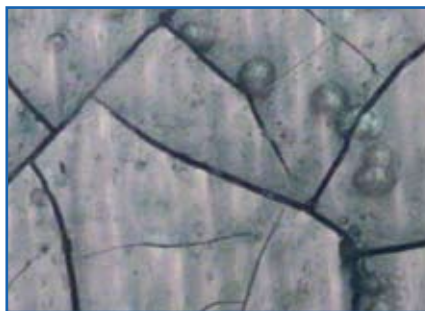


Figure 7. Anodized + Alumite AL. Needs no pre-aging.



Figure 8. Slightly anodized AL. Needs no pre-aging.

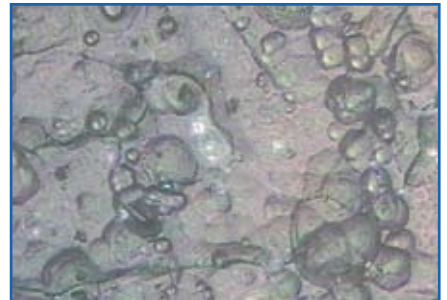


Figure 11. Anodized AL. Pre-aging required.

- Use low tack version (Tacsil® F20-L or Tacsil® F20-M) in order to prevent deformation of FPC during the removal.
- Double-sided FPCB
- Use standard version (Tacsil® F20).
- Multi-layer or thin rigid PCB
- Use high tack version (Tacsil® F20-H).

* The above recommendation is only a general guide and should be individually tested against the user's special conditions, including FPCB design and the contact area with Tacsil®. This will maximize the Tacsil's performance in your environment.

** If you have the trouble after adjusting the tack level according to the above recommendation, then try using contact area like in Figure 12.

Conclusion

Tacsil® can provide a unique, suitable solutions for assembly of flexible circuit

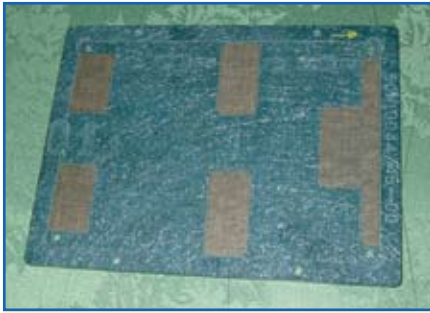


Figure 12. Partial Tacsil® with carrier.



Figure 13. Tacsil® with rigid-flex PCB.

boards, thin rigid boards and flip chip assembly, which is getting more popular every year and giving lots of challenge to the

engineers involved. Tacsil® will help engineers to achieve not only productivity and cost savings but also to increase yield and lower the default ratio with which engineers on shop floor struggle every day. And thanks to the very low, controlled level of silicone low molecular weight material, Tacsil® won't cause any practical problem during or after SMT soldering, such as solder non-wetting of FPCB or silicone contamination on connection parts - a concern for many SMT engineers. On top of the above, it is so easy to use and handling and doesn't require the use of any special utensil. It will make SMT engineers like a little easier.

Y.M.Lim is the managing director for Korea Taconic. He joined Taconic in early 1996, where he began working with sales, technical and other teams. He has also worked as a researcher at Kolon chemicals and as a manager in the planning and management department Kolon electro-materials.
ymlim@taconic.co.kr

K.Y.Park handles technical issues as technical manager with Korea Taconic. He has over 15 years of experience working in the CCL (copper clad laminate), PTFE (polytetrafluoroethylene) and silicone industries. He had previously

worked as a coating process engineer at Doosan electro-materials for eight years.
kypark@taconic.co.kr



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