Product

Application note E-Align

Self-adhesive - Room Temperature - Anisotropic Conductive Film

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1 SCOPE

This document outlines typical application areas and highlights key aspects to be considered when evaluating and introducing the E-Align Anisotropic Conductive Film (ACF) by CondAlign for industrial or laboratory use.

The document is intended as a guideline for users considering, evaluating and implementing the CondAlign E-Align ACF into a product or application.

2 PRODUCT DESCRIPTION

2.1 KEY FEATURES

The E-Align ACF from CondAlign is a range of self-adhesive anisotropic conductive films designed for application at room temperature.

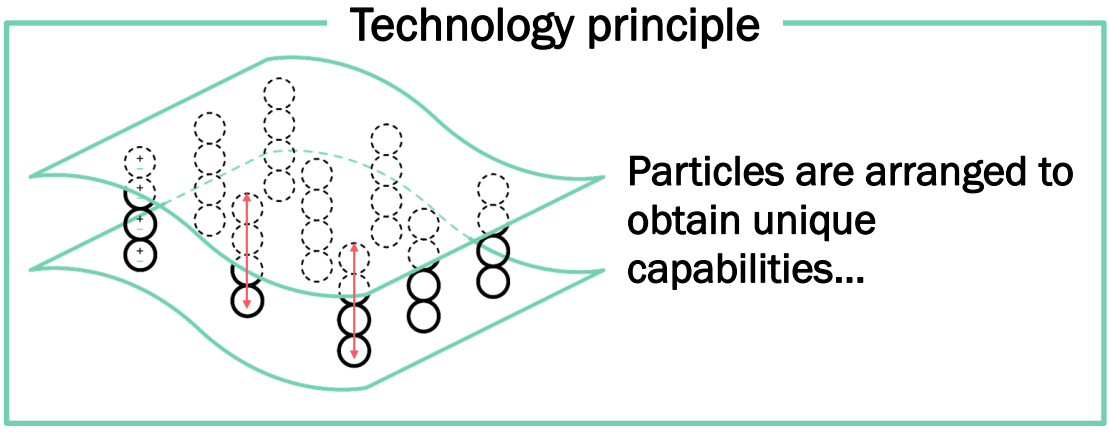
It is a double-sided tape with unique properties and features:

E-Align is a Pressure Sensitive Adhesive (PSA) that features anisotropic conductive properties in combination with unique adhesive properties. It enables instant bonding at room temperature with very low application pressure.

The anisotropic conductivity is achieved through aligning and locking conductive particles into chains through the z-direction of the film.
The chains are locked in place during production at CondAlign.
No additional process is required at the point of use. Neither high bonding pressures nor increased temperatures.

The electrical and mechanical properties make these films ideal for use in a wide area of emerging and innovative technologies.

The CondAlign ACF also offers a significantly reduced carbon footprint compared to alternative technologies. This is due mainly to reduced energy consumption and reduced precious metal usage.



2.2 INTENDED AREAS OF APPLICATION

The E-Align products offers cost efficient processing over a wide range of applications.

CondAlign E-Align ACFs are ideal for use where traditional electrical bonding and interconnection technologies have material incompatibility limitations or are too costly.

These limitations may be due to high temperature requirements for solder and curing processes or material properties like thermal expansion or brittleness.

The E-Align ACF provides both electrical and mechanical bonding in one step.

CondAlign products offer improved versatility and producibility through a conformable and bendable contact material.

Typical application areas include:
- Flexible Electronics
- Printed electronics
- Flexible, printed and paper batteries bonding
- Flexible Flat Cables
- Smart labels and IoT

Special application areas may be viable with additional considerations or ruggedization:
- In-moulded electronics
- Stretchable electronics

Please refer to relevant product data sheet for a full overview of properties and technical data.

3 COMPATIBILITY & RELIABILITY

CondAlign ACFs are easy to use and implement.
The product differs from established electric contact materials in some key areas. To achieve an optimal and reliable contact it is necessary to carefully consider the various aspects of use and fabrication.

Long term stability and material compatibility in the application should be carefully considered and evaluated based on application requirements, operational conditions, and environments.
It is highly recommended to thoroughly test and qualify the components for the expected lifetime and operational conditions.

This section focuses on the key aspects to consider:
- contact material selection
- substrate design and material selection
- surface energy and surface cleanliness

3.1 CONTACT CONDUCTIVE MATERIAL

The E-Align products are based on conductive chains formed of silver coated particles.
The silver is very well compatible with common contact materials utilized in electronics.

Materials like Copper (Cu), Nickel (Ni), Silver (Ag) or gold (Au) as well as AgPd, Platinum (Pt) or Palladium (Pd) are very well contacted using the E-Align material. Reliable contacts are also formed to carbon and carbon-fibre based materials with the right surface properties.

Common metals that may be non-compatible with the ACF includes stainless steels, tin (Sn) or solder dipped parts and aluminium (Al).
The background is complex. These materials may form a rougher surface that are challenging to contact. The main limitation is due to native insulating oxides that are not readily contacted by the silver coated particles when applied at room temperature and using low pressure.

For this reason, it is recommended to carefully select base materials for the application.
CondAlign recommends contact areas based on Cu, Ag, Ni and/or Au.

For component (top adherend) contacts it is recommended to select noble material variants like Ag, Cu. Pd, Pt, AgPd, NiPdAu or pure Au.
CondAlign ACFs have also shoved good ability to contact various Carbon (C) based electrodes, although higher variance between various Carbon quality and structure is observed.

3.2 SUBSTRATE BASE MATERIAL

The CondAlign ACF is intended for use with most flexible and rigid electronic substrate materials. Glass epoxy laminates, Thermoplastics like Polycarbonates (PC), PET, TPU, Polyimide and various paper-based materials are all suited for use.
The user is encouraged to test application and adhesion in the real application to reveal any concerns or issues related to the adhesion to low to medium surface energy materials.

3.3 CONTACT GEOMETRY, CIRCUIT LAYOUT AND STRAIN RELIEF.

The anisotropic film relies on chains of conductive particles formed through the thickness of the film. To achieve a reliable contact, a minimum number of conductive chains for each contact pad is necessary. Exact requirement will depend on electrical current requirements, mechanical interference etc and should be evaluated and tested on a case-by-case basis.
It is however recommended to have at least 1 mm^2 contact area for the 100 µm ACF variant.
For finer pitch variants 0.5 mm^2 contact area and smaller are achievable.
Due to the anisotropic properties the film will not short circuit neighbouring contact points. It is however recommended to maintain a contact pad distance of about 3 times the conductive chains pitch to guarantee isolation of the pads.

3.3.1 Electrochemical Migration considerations

Risk of electrochemical migration and dendrite growth should always be considered when designing circuit layouts.

3.3.1.1 Silver migration

Reliability concerns, such as silver migration should be considered when designing and laying out electronic circuits.
Presence of ACF on the circuit surface will protect against moisture sorption and subsequent migration and dendrite growth.
It is however recommended to design circuit layout to reduce potential differences between neighbouring pads to a minimum.

3.3.1.2 Tin whisker formation

Risk of tin whisker or tin-silver formation is a common concern related to electronics reliability. CondAlign ACF uses pure silver as the conductive material and is not dependent on solderability. The CondAlign ACF eliminates the need for tin based contacts and allows to remove this concern.

3.3.2 Strain relief

Unlike traditional contact materials used in electronics manufacture, the CondAlign ACF is a soft and flexible material. This enables the material to conform to shaped surfaces as well as being flexible to compensate stresses arising from movement and differences in coefficient of thermal expansion (CTE) in the material stack.
Due to the softness, it should be expected that the contact resistance is affected to some extent by external forces.
For this reason, it is recommended to implement means of strain relief. This is to minimize direct forces applied to the contact area as a result of excessive bending or manipulation.

3.4 OPTIMUM ADHESION - SURFACE ENERGY, QUALITY, AND CLEANLINESS

The adhesion to the contact metal and surrounding substrate is key to achieve a good and reliable electrical connection using CondAlign ACFs.

Three key aspects play an invariable role in adhesive performance:
- The surface energy
- Surface quality and roughness
- Surface cleanliness

In the following the role of these aspects for CondAlign ACF performance will be highlighted.

3.4.1 Adhesive wet-out

Substrate roughness and contact metal surface energy will affect adhesive wet-out and adhesion of the ACF.
Low surface energy materials oppose the flow of adhesive whereas high surface energy materials will promote the flow of the adhesive.
Contact metals like silver, gold or copper are high surface energy materials where good adhesive surface wet-out and bonds are easily achieved.
Common printed and flexible electronics substrate materials are low to medium surface energy materials that may represent a challenge in terms of adhesive bonding.

A rougher surface may increase the surface area and promote adhesion. The contact between the conductive chains and the surface may however be affected by excessive roughness and hence CondAlign recommends smooth and flat contact surfaces.

For the above-mentioned reasons, attention should be given to the application process to achieve proper adhesive wet-out of the surfaces to be joined together. This ensures the adhesive is in full contact with the surface and that the bond remains stable over time.

3.4.2 Surface preparation and environmental conditions during processing

CondAlign ACF can be applied at room temperature at normal indoor environmental conditions.
The substrate should also be at or near room temperature during application.

The surface should be clean, dry, and free of dirt, grease, or other contaminants before application.
If cleaning is necessary, it is recommended to use a mild detergent or solvent compatible with the substrate chemistry and that does not leave residues.
Allow the substrate to dry completely before application of ACF.

The metal surface should be smooth and clean to allow the conductive particles to make good contact.
Surface protection or Anti-tarnish treatment like e.g. Organic solderability preservative (OSPs) shall be avoided. These may isolate or prevent electrical conduction between the conductive chains and the base contact.
Metals that form a thick or non-conducting surface oxide will yield a higher contact resistance compared to more noble metals where surface oxides are not formed.

Due to the sticky nature of the ACF surface it is recommended to perform ACF application in a clean environment with measures in place to keep airborne contaminants low. i.e. low dust or dust-free clothing, hair nets, gloves, filtrated air or similar. Any debris, dust, fibre or similar that reaches the ACF surface will naturally tend to stick to it.

Once the top release liners are removed the sticky surface is exposed. It is recommended that liner removal is performed as short time as practical before the top adherend is attached to the ACF.

4 ENVIRONMENTAL RANGE

CondAlign ACF can be used across common operational conditions and cycles in terms of temperature, humidity, vibration, shock and manipulation.

When engineering and testing an application where the ACF shall be used it is important to consider the various aspects of the stack and structure where the ACF is used.

CondAlign encourages the users of E-Align ACF to test and qualify the performance of products built using the ACF across the expected environmental range and lifetime.

Refer to the product data sheet for environmental operational ranges.

Typical tests and ranges to be explored to verify product performance may be:

- Temperature range — Operational and non-operational
- Thermal cycles
- Physical manipulation — Axial forces, Bending, Torsion, Stretching
- Vibration and shock
- UV or visible light radiation

5 APPLICATION TECHNIQUES

To achieve a stable and reliable contact using the CondAlign ACF the application process should be designed carefully in accordance with the considerations described in the previous sections. Both the application of the ACF to the bottom adherend / substrate and the attachment of the component / top adherend will require consideration.

The electrical contact is formed immediately when using the CondAlign ACF. It is however common to see the contact and adhesive properties improve after the first application.
Depending on application, substrate, and materials this improvement may be observed over the first minutes, hours, and days. Ultimate adhesion strength is normally reached about 48 to 72 hrs after application.

The E-Align product is designed for one-time use. It is normally not possible to re-use the tape or re-apply a device if it has been detached.

5.1 TAPE APPLICATION TECHNIQUES

The ACF can be applied to the substrate in several ways.
An automated process is recommended for repeatability and process control.

Key parameters to be controlled and tuned are:

Parameter	Control range
Application methods	Roller Roll-to-roll Patches Other
Surface condition	Clean, dry
Even application	No trapped air bubbles
Surface contact	Complete and even adhesive wet-out
Application pressure	1 – 4 bars sufficient surface wet-out to be verified
Application time	Immediate
Application temperature	Room temperature
Ultimate adhesion strength	Reached about 72 hours after application
Top Liner removal	Minimize time before top adherend application

5.2 COMPONENT ATTACHMENT TECHNIQUES

The component or top adherend can be applied to the ACF by a method suitable for the application. An automated process is recommended for repeatability and process control.

Key parameters to be controlled and tuned are:

Parameter	Control range
Application methods	Pick and place Roll-to-roll Other
Surface condition	Clean, dry
Even application	No trapped air bubbles
Surface contact	Complete and even adhesive wet-out
Application pressure	1 – 4 bars sufficient adhesive wet-out to be verified
Application time	Immediate
Application temperature	Room temperature

5.3 DETACHMENT – ABILITY TO RE-USE COMPONENTS

A unique feature of the CondAlign ACF is easy removal and re-use of components.

Components assembled using the CondAlign ACF may be removed from the surface and readily re-used. Either for recycling or for repair during production.

The user is encouraged to explore this option as part of the life cycle evaluation of the final product.

Single components are easily removed by a firm grip and twist motion using a tweezer or similar.

Note that the ACF itself is not suitable for re-use after application.

6 MANUAL APPLICATION – HOW TO

The initial tests using the E-Align product is typically performed in a laboratory environment and through manual application.

In this section, basic recommendation and tips and tricks are highlighted to guide the user to a successful manual application.

To get to know the materials it is recommended to do a couple of dry runs before preparing live samples.

The material is typically delivered on rolls or on larger sheets. The ACF can be cut to the desired size and format using a sharp, clean scissor or a scalpel blade.

The basic recommendation is that the surfaces must be dry and clean.

The film should be applied in a way such that entrapped air and bubbles is avoided. The use of a squeegee or a roller will give best results.

The pressure should be light, but firm and sufficient to ensure the film properly wets the surface.

Liners should be removed right before application and in a fast and smooth manner.

The CondAlign ACF requires only a small positive pressure to bond to the surface.
The required pressure may vary between application, bonding surface area and substrate materials.
A pressure not exceeding 2.5 – 3 bar is sufficient in most cases.
It is recommended that the process parameters are investigated and optimized for each application.

The film is normally delivered between two release liners. One easy-release that will release first and one medium-release where the ACF will remain when the easy-release liner is peeled off.

For manual removal of liners, the "3M Scotch Magic tape 810" has adhesive properties that have proven to be suitable for effective liner removal.
This tape is attached on top of the liners and will lift the liners off the ACF when it is peeled off.

7 DISCLAIMER

All technical data or information provided in this document is given based on our best practice experience and to the best of our knowledge. Values are nominal or average and not appropriate for a specification. The user is responsible for determining if the CondAlign ACF product is fit for use in the particular use case and method of application.

CondAlign will always endeavour to help and assist its customers and product users to achieve best possible use of the products. Contact your CondAlign representative to enquire about the products.