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Data Sheet and Fabrication Guidelines
4.4.2

3001 Bonding Film Properties and Laminating Techniques

Rogers 3001 bonding film is a thermoplastic chloro-fluorocopolymer. It is recommended for bonding low dielectric constant PTFE (Teflon® fluorocarbon polymer) microwave stripline packages and other multilayer circuits. It may also be used to bond other structural and electrical components to the dielectric.

3001 bonding film features a low dielectric constant and low loss tangent at microwave frequencies, ensuring minimum interference with the electrical function of bonded stripline and other multilayer constructions. It is compatible with Rogers RT/duroid® low dielectric constant laminates, ULTRALAM® woven glass/PTFE microwave circuit laminates, RO3000® series high frequency circuit materials, RT/duroid® 6002 ceramic filled circuit materials, and other PTFE-based low dielectric constant substrates.

Its high temperature resistance and chemical inertness ensure that assemblies bonded with 3001 bonding film will meet or exceed the most stringent process and environmental specifications.

Reliable bonds can be achieved with 3001 bonding film using equipment readily available in the printed circuit fabrication industry. Laminating techniques are familiar to most circuit fabrication shops. The film is easily cut to size, and accurate relief holes for tooling slots and surface mounted launchers may be punched.

3001 bonding film is available in a thickness of 0.0015" (0.381mm), in continuous 12" (305mm) wide rolls, on standard 3" ID cores. Properly designed packaging and plastic cores ensure freedom from airborne contamination, and paper of cardboard "lint".

(See product data on page 4)

PREPARATION:

1. Copper: Following etching and stripping of the etch resist, copper circuitry should be treated with a light microetch to ensure complete removal of resist residues and to provide sufficient topography for sound mechanical adhesion. DO NOT mechanically clean.

NOTE: Do not use 3001 Bond Film when bonding to metal ground planes or where inner layers are mostly metal.

2. All surfaces to be bonded should be free of contaminants that impair adhesion, including dust, grease, oil, fingerprints, non-adherent oxides, salts or other process chemical residues. A final rinse of deionized water may be followed by a dip in clean isopropyl alcohol. Avoid use of compressed air which can deposit airborne contaminates such as oil.

   The PTFE surface as initially exposed by etching away electrodeposited foil is typically water-wettable and capable of forming a bond without a sodium etch treatment. Almost any kind of solid surface contact by scrubbing, swabbing, rubbing or normal stacking and handling will destroy that wettability by distorting the microscopic surface features left from the copper cladding. The result will be that a PTFE surface treatment will be needed to assure repeatability of a good bond. Treat the surface with one of the commercially available elemental sodium solutions such as Poly-Etch® or FluoroEtch®. Alternatively, sodium complex in liquid ammonia according to U.S. Patent 2,789,062 can be used. (Because of the high ceramic content on RT/duroid 6002, 6006, 6010, RO3000™ and RO3200™ families, surface preparation might not be needed and not recommended).

   Hot air oven baking should be used to assure removal of all solvent residues. This can be as little as 45 to 60 minutes at 121°C (250°F) but with some solvents such as acetone, methylene chloride or trichlor as much as 2 hours at 150°C (302°F) may be needed to assure complete solvent removal.

3. Staging: Boards prepared for bonding should be stored in a clean, dry environment. Generally layup and bonding should be done within 24 hours of surface preparation.

4. 3001 Bonding Film: The bonding film arrives ready for use and requires no further preparation. Handle the film in a clean, dust-free environment only with gloves to avoid contamination with skin acids and oils.

BONDING TECHNIQUE:

1. Layup: Assemble boards to be bonded interleaved with bonding film between dielectric layers. In cases where registration is critical, the plates should be provided with pins and the boards and film with holes. Clean room or filtered air flow conditions are recommended. A thermocouple inserted at the bond line is recommended for observing the lag time for reaching the bonding temperature. Thermocouples should be small diameter and located where they will not damage the part or interfere with pressure uniformity.

2. Clamp: While the press is cool, typically below 120°C (248°F), center the assembly package on the platen area. Close the press and adjust the hydraulic system so that the bond area receives the desired pressure. Generally 100 psi is sufficient but up to 200 psi may be required to assure flow of the bonding film when the copper pattern occupies a greater part of the bond areas.

   Clamping in a cool press followed by heating is important for uniformity of temperature across the bond area as the bonding film fuses.

3. Heat: Start the platen heating cycle toward a 220°C (428°F) set point. Generally the maximum heating rate is acceptable as long as enough control is used to keep the upper and lower platens at nearly the same temperature, within 1 to 5°C.

4. Dwell: Hold the temperatures at the bond line at set point for a minimum of 15 minutes. This allows the film, in its melted state, time to flow and wet the surfaces to be bonded. The embedded thermocouple is useful to be sure the bond line actually sees this dwell. For thick layups there could be enough lag in heating to require an extended dwell. Sometimes dwell might need to be increased to 30-45 minutes.

5. Cool: Turn the heating power supply off and cool the platens while continuing to maintain the clamp pressure until the temperature is down to 120°C (248°F). Remove pressure and take the assembly out of the press. Platen cooling water flow could be stopped at this point to save on heating time on the next cycle since 120°C (248°F) is cool enough for clamping in Step 2.

Notes:

a. A maximum bond strength may be achieved using a press temperature of 232°C (450°F) for most standard RT/duroid laminates or their equivalents clad with electrodeposited copper and etched (but not sodium etched). 3001 bonding film has minimal adhesion to copper and should not be used where large copper surfaces are present.

b. The bonding parameters of temperature, pressure and time are interrelated and may be adjusted somewhat to suit individual requirements. The minimum possible bonding temperature is 199°C (390°F), while temperatures over 246°C (475°F) should be avoided to prevent excess flow. Excessive temperature may result in material decomposition and excessive fuming. Vacuum lamination (14 psi) has been used to obtain a satisfactory bond.

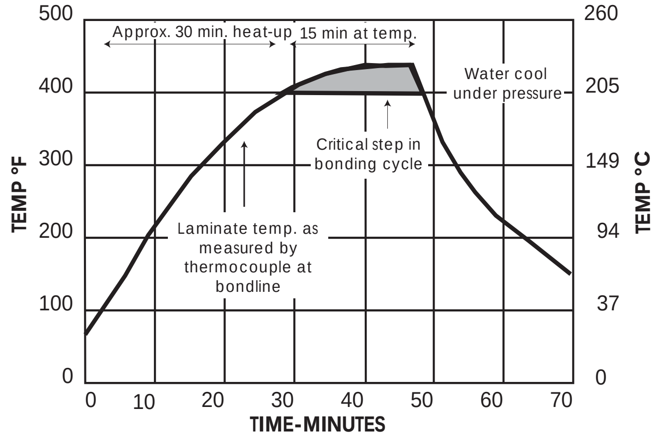
c. In some cases, it may be feasible to increase productivity by a transfer press technique in which the board assembly in a metal plate fixture is clamped in a hot press where it quickly reaches the 220°C (428°F) set point and dwells long enough to melt and flow. The pressure is then released and the assembly moved and reclamped at once in a second press at 120°C (248°F) where it quickly cools to freeze the bonding film. Design the fixture with enough thermal capacity and in-plane thermal conductivity to avoid uneven heating, and to minimize premature heating or cooling during press transfers. Pressure must be re-applied before bond line temperature drops below 220°C (428°F).

d. Bonding presses should be well maintained and in good working order. Features such as platen flatness, degree of parallel, temperature uniformity at heating and cooling, etc, as well as routine lamination practices should agree with generally accepted industry guidelines as well as those of the manufacturer. For further information the following references may be consulted: *Printed Circuit Handbook, C.Coombs, McGraw Hill, 1988; The Multilayer Printed Circuit Handbook, J.A. Scarlett ed., Electrical Publications 1985.*

e. Packages properly bonded will yield a bond strength (peel) in excess of 20 lbs. per inch width.

Safety Note:

As with all halocarbon polymers when subjected to temperatures at or above their melting point, adequate ventilation should be provided.



A time-temperature curve as shown on the accompanying chart illustrates a typical press temperature cycle which has produced satisfactory bonding results.

TROUBLE SHOOTING:

No Bond

1. Surface of board to be bonded was mechanically cleaned (pumice scrubbed, brushed, etc.).
   Solution: Do not mechanically clean. Use chemical cleaning procedure.
2. Inadequate temperature-time above minimum bond temperature.
   Solution: Double check temperature at bondline with thermocouple.
3. Contamination with release agents, moisture, dirt, etc.
   Solution: Review cleaning and priming procedures and conditions.

Spotty Bonding or Blistering

1. Non-uniform pressure.
   Solution: Use fresh padding or additional padding. Check flatness or press.
2. Inadequate temperature.
   Solution: Double check temperature at bondline with thermocouple.
3. Inadequate rinse and dry of cores prior to bonding.
   Solution: Review cleaning and drying procedures. Review storage conditions and duration of time between preparation and bonding.

Distortion

1. Excessive temperature.
2. Non-uniform pressure.

Typical Values

3001 Bonding Film

PROPERTY		TYPICAL VALUE	DIRECTION	UNITS	CONDITION	TEST METHOD
Dielectric Constant		2.28	Z	-	X-band [1]	IPC-TM-650, 2.5.5.5
Dissipation Factor		0.003	Z	-	X-band	IPC-TM-650, 2.5.5.5
Volume Resistivity		10^{11}	-	Mohm/cm	25°C	ASTM D257
Surface Resistivity		10^{9}	X,Y	Mohm	25°C	ASTM D257
Dielectric Strength		2500	Z	V/mil		ASTM D149
Thickness		0.0015	Z	inch		Micrometer
Water Absorption		0.05		%	24hrs/23°C	ASTM D570
Bond Strength		1400	Z	psi	A	[2]
Tensile Strength	**MD**	7.5	X	kpsi		ASTM D882
	CMD	5.5	Y			
Elongation	**MD**	115	X	%		ASTM D882
	CMD	200	Y			
Youngs Modulus	**MD**	140	X	kpsi		ASTM D882
	CMD	150	Y			
Thermal Conductivity		0.22	Z	W/m/K		
Maximum Use Temperature		176		°C		
Crystalline Melt	**Nominal**	186		°C		

Chemical Resistance - 2 weeks/ambient	**Weight Increase (%)**	**Visual Effect**		**Weight Increase (%)**	**Visual Effect**
Acetone	5.17	Cloudy, Very Flexible	Methyl Ethyl Ketone	5.9	Very Flexible
Ammonium Hydroxide	None	None	Nitric Acid - 70%	None	None
Carbon Tetrachloride	4.1	Flexible	Sodium Hydroxide - 50%	None	None
Ethanol	None	None	Sulfuric Acid - 30%	None	None
Hydrochloric Acid - 36%	None	None	Toluene	2.8	Flexible
Hydrofluoric Acid - 60%	None	None	Trichloroethlene	10.9	Cloudy, Very Flexible
Methanol	0.1	None	Trichlorofluoro-ethane	-	Cloudy Very Flexible

Typical Values are a representation of an average value for the population of the property. For specificiation values contact Rogers Corporation.

Shelf life: 3001 bonding film is a thermoplastic. As such, there are no shelf life limitations.

Notes:
[1] Two stacks of 40 piles of film are used.
[2] A specimen of two 0.062" thick pieces of RT/duroid®5880 microwave circuit laminate is machined with 0.500" diameter groove cut just through the bond line on one side and concentric with a 0.375" diameter hole just through the bond line from the other side. Breaking force to pull apart the isolated bond area of 0.375" ID/0.500" OD (0.86 in.^{2}) is measured at 0.050 in/min. cross head speed.
[3] Differential scanning calorimetry test is on a 8 mg specimen which was melted by heating to 240°C followed by slow cooling to 40°C before a second heating for the measurement.

The information in this data sheet and processing guideline is intended to assist you in fabricating Rogers' circuit material laminates. It is not intended to and does not create any warranties express or implied, including any warranty of merchantability or fitness for a particular purpose or that the results shown on this data sheet and fabrication guideline will be achieved by a user for a particular purpose. The user should determine the suitability of Rogers' circuit material laminates for each application.

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