TMM® Microwave Laminates Bonding Notes

TMM® microwave laminates are ceramic thermoset polymer composites for use in high reliability stripline and microstrip applications. TMM laminates combine low thermal coefficient of dielectric constant, a copper matched coefficient of thermal expansion and the best dielectric constant uniformity of any substrate in the market. These properties make TMM laminates ideal for many applications.

The need for bonded TMM stripline assemblies has led to a study of commercially available bond films. The bond films in the evaluation were the following:

- Dupont FEP Type C20 (both sides cementable)
- Rogers 3001 CTFE film
- Dupont FEP Type A

Unfortunately, these films have a low dielectric constant which will change the overall dielectric constant of the stripline assembly. The effect of the film depends on the circuitry topology, material grade and thickness and will therefore have to be evaluated on a per application basis.

Samples of TMM 3 and TMM 10 were evaluated with all films. Copper was etched off on all samples and baked for one hour at 110°C prior to bonding. TMM laminates do not have to undergo a sodium etch operation like PTFE/Glass laminates in order to render the surface wettable. The films used were two mils thick. Bonding was done in a flat bed press (6" x 6") preheated to 300°C for FEP films and 220°C for the CTFE film. Pressure was kept at 200 psi throughout the cycle while soak time was 20 minutes at the above-mentioned temperatures. The samples were divided into three groups and tested after different conditioning. The results of the testing are given in Table I.

Material and Bond Film		Bond Strength (lbs/linear inch)	
	Condition A	Thermal Stress	Temperature/Humidity
TMM 3- FEP C20	12.4	13.5	13.7
TMM 3 - CTFE	10.2	12.4	7.0
TMM 3 - FEP A	6.7	6.4	7.4
TMM 10 - FEP C20	13.6	12.9	13.8
TMM 10 - CTFE	12.3	12.2	6.3
TMM 10 - FEP A	6.5	5.7	6.4

Table I

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Sample Preparation After Bonding

1. Condition A (as is).
2. Thermal Stress. Samples were floated for 10 seconds in a 288ºC solder pot.
3. Temperature/Humidity Conditioning. Samples were placed in a pressure cooker for two hours after full pressure (17 psi) was reached.

Results indicate that FEP C20 provides best results for all conditioning environments. Rogers 3001 film fared well when conditioning was limited to as is and thermal stress, but should not be used when "hot/wet" testing is required. FEP Type A yielded low peel strength under all conditions and should not be used at all. Table II provides bonding guidelines of TMM Laminates.

Recommended Bonding Guidelines for TMM Temperature Stable Microwave Laminates

Bond film type	Dupont FEP C20 film, ε_r=2.1 @ 1 KHz
Bond Temperature	300ºC
Bond Pressure	200 psi throughout cycle
Cycle time	20 minutes at temperature
Set up Vacuum bonding or purge with Nitrogen	

Table II

PRECAUTIONS:

1. Rapid tool wear while drilling bonded TMM assemblies may result in excessive smearing of the soft fluoropolymer adhesive layers. Hit counts will depend upon dielectric thickness and design requirements and should be determined by inspection of the drilled holes.

2. Even though TMM laminates do not need to go through sodium etching prior to plated through hole processing, once bonded with FEP C20 or Rogers 3001 sodium etching will be necessary. The reason being that electroless copper will not adhere properly to the thin layer of film and will therefore provide a weak link to the hole wall. FEP Type C20 film can be obtained direct from Dupont or:

   Saunders (West Coast)
   A Division of R.S. Hughes Co., Inc
   975 N. Todd Avenue
   Azusa, CA 91702
   888-932-8836

   Saunders (East Coast)
   A Division of R.S. Hughes Co. Inc.,
   1119 N. Main Street
   Lombard, IL 60148
   888-932-8836

3. Prolonged exposure in an oxidative environment may cause changes in the dielectric properties of all hydrocarbon based dielectric materials, including RO4000® [or TMM] high frequency dielectric materials. Changes may be exacerbated by increased thermal exposure. Whether or not such changes occur, and whether or not they might result in a functional impact on a finished product, depends on a complex set of variables related to factors such as circuit design, functional tolerances, operating conditions and other circumstances that are unique to each product design. Although Rogers continues to seek ways to minimize the naturally occurring effects of oxidation by developing improved anti-oxidant formulations for the RO4000 [or TMM] family of high frequency materials, Rogers, as always, recommends that the circuit designer and/or the end user test the properties and performance of these materials in each proposed application to determine their fitness for use over the entire product life.

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