

FABFILE *Online Newsletter*

Volume 2, Number 1, February 20, 2004

<http://www.fabfileonline.com>



Harvey Miller

How **FABFILE Online**® was put online in less than five months

Fabfile Systems effectively closed April 2003. That gave Harvey Miller, long associated with that entity, the great opportunity to offer a new product using the latest web-based delivery mechanism. A main feature of this Web-based product is instant access to dynamically changing information. It will enumerate data changes on a daily basis, coded by company ID# for clients, continuously accessible at the **FABFILE Online**® website

<http://www.fabfileonline.com>

PTFE substrate Materials for Microwave Circuits

by Robert C. Owens

The materials used to make RF and microwave PTFE circuit boards are of necessity made of a mixture of materials. Teflon® is the key to good performance. In fact, circuit boards would be made from this material except for the fact that its mechanical properties are not adequate to meet most requirements. In the 1960's, the first boards were made using a woven fiberglass impregnated with Teflon. This material is very strong mechanically and reasonably stable over temperature ranges encountered in most applications.

The non-uniform nature of the weave, however, does cause performance deficiencies at higher frequencies. To solve this problem, a material with the same components (Teflon® for performance, fiberglass for strength) was introduced in a composite form, with the components being ground up and mixed together. (In fact, the early boards were made using paper making machines). The strength

was not as good as the woven materials, but the electrical properties were better.

What are the properties that are important in PTFE substrates? They divide into two equally important categories: Electrical and mechanical. In the rest of this discussion, we will briefly describe each key property.

Electrical Properties

The first requirement a circuit designer looks for is the dielectric constant, or the relative permittivity. When an electric field is applied to any dielectric, there is a realignment of the atomic structure which produces an internal field. The strength of that field is determined by its permittivity. The dielectric constant of free space (and air) is 1. Pure Teflon® is about 2.1. Ceramics can have much higher permittivities. For example, Alumina (Al₂O₃) has a relative permittivity of around 9.6, depending on the formulation. The fiberglass mixed in with the Teflon generally produces a dielectric constant in the range of 2.2 to 2.6. The higher the permittivity, the shorter a quarter-wavelength piece of line will be. PTFE boards provide shorter lines from their free-space lengths by a factor of about 1.4.

The second electrical property of interest is the loss, usually described in terms of the loss tangent. Plain old FR-4, used extensively at lower frequencies, has a loss tangent of 0.03. Good microwave materials can be in the range of 0.001.

There are materials, such as GETEK® with a compromise of 0.01. There is generally a trade-off between low loss and cost.

Mechanical Properties

Although not a part of the electrical design, mechanical properties are important to consider for the complete design process. The first is strength. As mentioned above, PTFE boards have a range of strength. Woven boards have a tensile strength of 25-35 MPa, while composite boards are around 15-20 MPa. When a board is supported by a mechanical housing, the weaker boards can be used with relative ease. However, boards which must provide mechanical strength are best done using the woven materials.

continued on page 2

Putting FABFILE Online® online

First, we made the decision to modernize to a web application. Data was previously delivered every 3 months by CD.

Next, we located a suitable database developer to design and implement the web application. It's not like an Amazon or eBay catalogue.

Then came design of the new system.

That involved conversion from the old system.

Finally, came implementing the new system, refining, and testing it.

Then an inspired afterthought, we provided the newsletter online to communicate updates to clients and share.

CONTENTS

| | |
|---|---|
| How FABFILE Online ® was put online in less than five months | 1 |
| PTFE substrate Materials for Microwave Circuits | 1 |
| The Flex Circuit Boom Has Just Begun | 2 |
| The Suspension Assembly Flexible Circuit Wars | 2 |
| Discussion of Japanese and U.S. Flex Circuit Fabricators | 3 |
| Comparing the Profiles of the Major Japanese and U.S Flex Circuit Fabricators | 3 |
| Fabfile Online Forms Exclusive Sales Alliance | 4 |

continued from page 1

Finally, thermal expansion is often a key consideration. A long piece of circuit material mounted to an aluminum housing can actually break under temperature stress if the board material does not match the movement of the metal. Fortunately, most PTFE boards (15-25ppm/°C) are reasonably close to commonly used metals (Copper 16-18 ppm/°C), and expansion is not a problem. Refer to [Table 1](#). for a list of microwave printed circuit fabricators.

Table 1. Microwave Printed Circuit Fabricators Sorted by Fabfile Online

| |
|---|
| Anaren |
| Buffalo Circuits |
| Celect Circuits |
| Circuit Express Div |
| Circuit Tech |
| Cirexx |
| Cirtech |
| Collins Printed Circuits |
| Cyclotron |
| Electropathdata Design Circuits |
| Data Design Circuits |
| Excel Precision |
| Filtran Microcircuits |
| Galaxy Circuits |
| IMI |
| Maryland MPC |
| Merix |
| Micro-Chem |
| Microwave Circuit Technology |
| Mid-Atlantic Circuits |
| Millitech Corp |
| Modular Components National |
| PC Dynamics Div |
| PC Specialties Inc. |
| Performance Interconnect |
| Poly Circuits |
| Proto Circuits of Florida |
| Transline Technology, Inc. |
| TRC Circuits |
| Triangle Labs |
| Tyco San Diego |
| U.S. Microwave |

The Flex Circuit Boom Has Just Begun

Flex circuits barely noticed the electronic industry dip of 2000-2003, so Greg Albert of Kaneka, makers of Apical polyimide film for flex circuits, told me at the IPC TMRC meeting in Minneapolis, October 1, 2003. He was a bit embarrassed reporting such good news in the midst of the gloom, representing an industry that

was up strongly throughout the general downturn.

Many new applications are driving flexible circuit growth - RFIDs for tracking products, to smart cards, cell phone cameras, displays, printer cartridges, and of course, missiles. Along with Defense, disk drives and semiconductor packages are at the top of the performance-value heap. A new generation of tiny disk drives is going into portable electronics, with even more exacting density requirements for the flex circuits.

Hard disk drives have always used an actuator flex; a new flexible circuit growth market in head flexure assemblies that has emerged since the mid-1990's. Its genesis is described in the accompanying article.

An application being developed by Joseph Fjelstad of Silicon Pipe for flexible circuits will place them right square in the middle of mainstream interconnection, where rigid printed circuit boards now sit. He would replace rigid board wiring for critical high speed signal connections among chips, banishing by direct connections, the discontinuities, reflections, and crosstalk that now limit performance and speed. Flex is a natural for direct connection. An analogy is Minneapolis in January. Why freeze on the street, when you can travel by skyway far above it?

See the Silicon Pipe website for more details: <http://www.sipipe.com>

The Suspension Assembly Flexible Circuit Wars

Until the mid-1990's a 2 wire harness made by Innovex was used to connect the disk drive head, which was then ferromagnetic. The interconnection assembly was and is part of the suspension assembly; its characteristics are critical to head operation. Higher speeds and density of magnetoresistive write heads, used in addition to magnetic read heads created need for conversion to a 4 trace flex circuit using adhesiveless substrates for greater stability and

finer resolution. Microstrip construction uses the stainless steel suspension as ground for the flex circuit signal traces.

Hutchinson was dominant in etching of the stainless steel suspensions. So it was a natural step to provide the flex interconnect since they had that capability also. Hutchinson with its Trace Suspension Assembly flex circuit, took the suspension-head interconnect business from Innovex' wire harness. Innovex in turn was motivated to enter the flex business by buying Litchfield, then Adflex. Adflex dominated the disk drive actuator flex business, so that acquisition was complementary marketwise. HTC uses a Rogers-Mitsui Chemical joint venture, Polymer Laminate Systems as the materials source for Flex-I-Mid cast adhesiveless material.

HTC sells about 500M Trace Suspension Assemblies per year, 60% of the market, at about \$0.80 each. The flex portion of the assembly represents about a third of total value. Innovex wants part of that pie with its Flex Suspension Assembly.

But Innovex, working with Applied Kinetics, has also developed an innovative flex-only replacement for the entire stainless steel suspension, the Flex Gimbal Suspension Assembly.

Innovex doesn't etch the stainless steel suspension sometimes termed a slider, so its acceptance would definitely increase market share. Its success would narrow further participants in an already narrow marketplace. This is a market wherein volumes are very high, technical requirements very stringent, and cost very critical. By its nature, there isn't room for many competitors.

Three other participants in the market are KR Precision, Thailand, NHK Spring, Japan, and Magnecomp, Singapore. There is a pattern of cross licensing among them with Hutchinson and/ or Innovex. Magnecomp has secured 2nd place by supplying complete suspensions to the fast-growing mini disk market. Commerce is an important aspect of their competitive interrelationships; since Innovex doesn't etch metal and only Innovex, Hutchinson, and Magnecomp, through joint venture, Optimal, in China, fabricate flex circuits. 3M also serves the suspension flex market, a diversification from ink jet printer cartridge concentration.

Discussion of Japanese and U.S. Flex Circuit Fabricators

Market concentrations reflect 1) end market applications characteristic to each country and 2) initial involvement in those markets when domestic production predominated. These high volume markets include printer cartridges, cameras, cell phones, IC packaging, HDDs, displays. The highest volume manufacturers serve one or more markets.

Table 2. Top 10 Japanese Flex Circuit Companies, Business Volume^a

| Company Name | \$ (Millions) |
|---------------------|----------------------|
| Nippon Mektron | 887 |
| Shinko Electric | 420 |
| Fujikura | 312 |
| Sony Chemical | 260 |
| Nitto Denko | 233 |
| Sumitomo Electric | 212 |
| Shindo Electric | 167 |
| Mitsui Metal | 150 |
| Sumitomo Bakelite | 125 |
| Hitachi Cable | 78 |
| Totals | 2,844 |

a. Source: N.T. Information

Table 3. Top 7 U.S. Flex Circuit Companies, Business Volume^a

| Company Name | \$ (Millions) |
|---------------------|----------------------|
| 3M | 380 |
| Innovex | 150 |
| Hutchinson Tech. | 120 |
| M-flex | 100 |
| Parlex | 92 |
| Sheldahl | 80 |
| Minco | 70 |
| 70 Others | 275 |

a. Source: Fabfile Online, 2003 Flex Circuit Fab Database

Comparing the Profiles of the Major Japanese and U.S Flex Circuit Fabricators

Together, the two industries represent two-thirds of world flex production value. Japanese companies account for half the total.

End market applications are characteristic to each country, stemming from involvement in those markets going back to the days when domestic production predominated for each company

The Japanese high-volume market concentrations areas:

- 1) Cell phones and Cameras
- 2) IC packaging
- 3) LCD displays.

The U.S. company market concentration areas:

- 1) Hard Disk Drives (HDD)
- 2) Automotive
- 3) Ink Jet Printer cartridges

For more information about the Japanese flex circuit fabricators, see the following flex circuit article on the **PCB007.com** website:

<http://www.pcb007.com/intelligence/article.asp?id=670>

Or, contact Dr. Nakahara-san of N.T. Information directly by email at

nakanti@yahoo.com

For more information about the U.S. flex circuit fabricators, contact Mr. Harvey Miller directly by email at:

harvey@fabfileonline.com

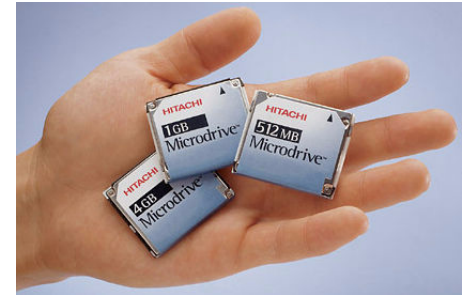


Figure 1: 4 GB in the palm of your hand. These miniature HDDs are made possible in large part by flex technology.



Figure 2: The components of the miniature HDDs are vastly scaled down versions of the more common 3.5" and 5.25" HDD platforms.

Table 4. Partial List of February 2004 Fabfile Online Database Updates

| FABFILE Online® Database Updates for February 2004 | |
|---|--------------------|
| Companies | Notes |
| Advance Circuits Inc | |
| Advanced Circuit Technology | |
| Advanced Electronics | |
| Alltek Circuit | |
| Alpha Circuit Corp | |
| American Circuit | |
| American Circuits | |
| American Flex Circuits | Changed Name |
| Ampel Corp | |
| Arnold Electronics | |
| Bay State Circuits | |
| Beckman Coulter | Business Up 25% |
| Buffalo Circuits | |
| Capital Electro-circuits | |
| Carlo Gavazzi | Embedded Computers |
| Cartel Electronics | |
| Champion Circuits | Moved |
| Chautauqua Circuits | |
| Circuit Engineering | |
| Circuit Express | |
| Circuit Partners | |
| Circuitronics | |
| Circuits Grm | Business Up 10% |
| Cleveland Circuits | |
| Crest Circuit | Business Up 50% |
| Crimp Circuits | |
| Cyclotron | |
| Delta Precision Circuits | |
| Dynaflex Parlex | |
| Electronic Components & Services | |
| Elreha St. Petersburg | |

Table 4. is a partial list of the February 2004 updates to the *FABFILE Online*® database. For a complete list of updates, go to the Updates tab on the *FABFILE Online*® website at <http://www.fabfileonline.com>.

Fabfile Online Forms Exclusive Sales Alliance

The Industry's most comprehensive database of PCB Fabricators joins forces with the Excelrel group to drive marketing and sales in the PCB industry.

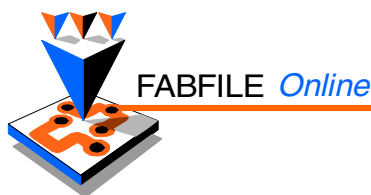
“We are very excited to be part of the *FABFILE Online*® team,” said Ray Rasmussen, former publisher of CircuiTree Magazine and co-founder of Excelrel. “We believe there is a lot confusion in the North American Market, right now as the status of hundreds of facilities has changed over the last few years. *FABFILE Online*® has the most complete, up-to-date database of fabricators in the industry. Suppliers using *FABFILE Online*® can quickly and easily come up-to-speed with all the unprecedented changes in this market. It's a great value and we're pleased to be part of this offering to the industry.”

For more information, go to the Fabfile Online website Press Release tab at:

<http://www.fabfileonline.com/>

Or, send an email with your questions to: info@fabfileonline.com.

For sales information, please contact Barry Matties, toll free at 866-FABFILE (866-322-3453) or send an email to Barry at info@fabfileonline.com.



FABFILE Online
 255 Town & Country Village
 Palo Alto, CA 94301

 Telephone (866) 322-3453
info@fabfileonline.com
<http://www.fabfileonline.com>

