SUMNotes
PUBLISHED BY BUEHLER, A DIVISION OF ILLINOIS TOOL WORKS
VOLUME 2, ISSUE 1

PREPARATION OF FLEXIBLE CIRCUITS

Introduction

Electronics play a major role in the world around us. Everyday we take advantage of flexible circuits in our phones, digital cameras, automobiles, and personal computers.

The concept of flexible circuitry is thought to originate with a patent issued to Albert Hanson of Berlin, Germany in 1898. Hanson's patent describes the production of flat conductors on a sheet of paraffincoated paper. (1)

While waxed paper provided ample flexibility, today's product is sandwiched between a polymer cover layer and base film of either polyimide or polyester. Polyimide is favored where soldering of the assembly is required and is the material of choice for nearly all chip scale packages and flex ball grid arrays. Polyester is generally used in low-cost applications and has been successfully used in the creation of Smart cards.

Flex circuits are produced in several basic forms that generally parallel rigid PWB construction. (1)

Single-sided flexible circuits
- Most common type in production today
- Most often employed and best suited to dynamic flexing applications

Back-sided flex circuits
(also known as double-access flex circuits)
- Contain only a single conductor layer
- Processed to allow access to the conductors from both sides
- Often employed for integrated circuit packaging

Double-sided flex circuits
- Contain two conductor layers
- Can be produced with or without plated through holes

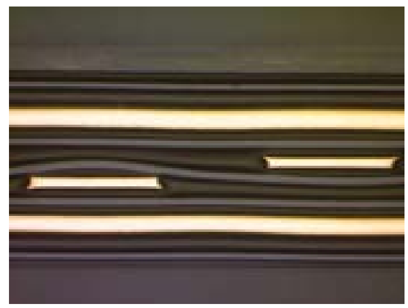
Multilayer flex circuits
- Have three or more conductor layers
- Layers of the circuit are interconnected with plated through holes

Rigid flex circuits
- Hybrid construction, consisting of rigid and flexible substrates laminated together
- Electrically interconnected by means of plated through holes

Continued reduction in the size and weight of electronic components has enabled many advances in both consumer and medical markets. In order to meet these demands, continuous improvements in the design and processing of the circuitry have occurred.

Metallography plays an integral role in analyzing and understanding the effects of these improvements on the internal structure. Quality control will benefit from evaluating the product at various stages of a new production process. The cross-sections can reveal vital details including cracks, voids, conducting layers and interconnections.

In other cases, a more targeted approach might be applied. It may be desirable to cross-section the centerline of through holes or progressively thin the specimen and examine each layer. The more information gathered during an analysis, the greater the probability that the product can be further improved. Specialty equipment, such as the Buehler PC-Met® High Volume Printed Wiring Board Preparation System is available to simplify these tasks.



Four layer, bi-directional flex circuit crosssection. 50x magnification.

Preparation Procedure

1. Determine the best location to cross-section the circuit. Using a sharp instrument, such as a razor blade, smoothly cut the circuit as desired.
2. Secure the specimen between two glass slides for support. Adhere with TEM Epoxy, clamp and place in an oven at 100° C (212 °F) for approximately 10 minutes or until cured.
3. Select an appropriate embedding medium based on the maximum temperature that the specimen can withstand without distorting. Both EpoxiCure® 2 and EpoHeat® Epoxy Systems are recommended based on their viscosity. EpoHeat reaches a cure temperature of about 295 °F (146 °C) whereas EpoxiCure® is approximately 104 °F (40 °C).
4. Attach a clip (UniClip Specimen Support Clips) to the specimen to provide support while pouring the epoxy. Place the sample with clip into the sample clip. It is important that the specimen remains upright such that the grinding surface is perpendicular to the sandwiched flex circuit.
5. Encapsulate the specimen in epoxy with the aid of vacuum impregnation to ensure good adhesion and penetration. Allow the specimen to cure before removing the base.
6. Grind until a flat plane has been achieved or the desired depth is reached using 600 (P1200) grit CarbiMet® Silicon Carbide Paper. Water is recommended as the lubricant.

When an automated polisher, such as the AutoMet® or EcoMet®, is employed, set the following parameters: 4lb (20N) force per sample, 25 RPM for the base and contra rotation between the base and head.
Automating the preparation process can provide more controlled material removal and better consistency from operator to operator. When working manually, it is often difficult to maintain even pressure across the surface. Uneven pressure can produce artifacts by essentially creating an angled specimen. The specimen layers will appear thicker and key features may be distorted.

7. Continue grinding with 800 (P1500) and 1200 (P2500) grit MicroCut® Abrasive Discs. Use the same parameters as above for an automated system. Each step should take approximately 1 minute.

To determine if the time is sufficient, observe the specimen surface under a microscope at the end of each step. Scratches proportional to the current abrasive size will be present. A uniform scratch pattern that doesn't improve regardless of the time spent indicates that the current step is complete. Clean the specimen thoroughly and move to the next step.

8. Use a TriDent® Cloth for the next step. Apply 3mm MetaDi® Supreme Polycrystalline Diamond Suspension. The hard woven cloth with a firm backing will assist in minimizing edge rounding. Set the following parameters for an automated system: 5lb (25N) force per sample, 200 RPM for the base and contra rotation between the base and head. This step should take approximately 12 minutes.

9. Perform a final polish with MasterMet® 2 Non-crystallizing Colloidal Silica Suspension on a ChemoMet® Polishing Cloth. Once again the basis for the cloth selection is to minimize edge rounding. Set the following parameters for an automated system: 6lb (30N) force per sample, 150 RPM for the base and complementary rotation between the base and head. This step should take approximately 3 minutes.

10. Clean and examine the cross-section. Determine the average thickness of plated layers, note any inner-layer separation and complete all other evaluations per customer's specifications.

Equipment*
SimpliVac® Vaccum System
AutoMet® Grinder-Polisher

Consumables*
Tem Epoxy
Glass Slides
EpoxiCure® EpoHeat® Epoxy
UniClip Specimen Support Clips
SamplKup® Mounting Cups
Release Agent
CarbiMet® Abrasive Discs
Trident® Cloth
MetaDi® Supreme Polycrystalline Diamond Suspension
ChemoMet® Polishing Cloth
MasterMet® 2 Non-crystallizing Silica Suspension
MicroCut® Abrasive Discs
For a complete listing of Buehler Equipment and Consumables, please refer to Buehler's Product Catalog or www.Buehler.com

References

1. Joseph C. Fjelstad "Tutorial: An Overview of Flexible Printed Circuit Technology" Chip Scale Review, Jan-Feb 2001. (http://www.chipscalereview.com/issues/0101/tutorial_01.html) last viewed Feb 2, 2007.

BUEHLER

BUEHLER Worldwide Headquarters
North America-South America Offices
41 Waukegan Road
Lake Bluff, Illinois 60044-1699 USA
P: 800 BUEHLER (800-283-4537)
P: (847) 295-6500
www.buehler.com | info@buehler.com

European Headquarters
BUEHLER Germany
info.eu@buehler.com

BUEHLER France
info.eu@buehler.com

BUEHLER United Kingdom
info.eu@buehler.com

BUEHLER China
info.cn@buehler.com

BUEHLER Japan
info.japan@buehler.com

BUEHLER Asia-Pacific
info.asia@buehler.com

© 2024 BUEHLER, a division of Illinois Tool Works Inc. Printed in U.S.A.