New Products

Copper Foils for the Printed Circuit Boards of the Future

As a material supporting the increasingly rapid trend toward smaller size and higher performance of electronic equipment, electrodeposited copper foil is subject to the following requirements in terms of properties:

(1) Thinner foils with less surface roughness to enable fine patterning;
(2) Improved flexibility to enable use in mobile phone hinges;
(3) Surface finishing that supports adhesion even to high-function special plastics;
(4) Heat resistance to enable use with plastics requiring high-temperature processing;
(5) Foils having functions for built-in components.

To meet these requirements, Furukawa Circuit Foil has completed development of the following copper foils, and has brought them to the mass-production stage.

1. U-WZ Copper Foil for COF

Features: Flat, with low surface roughness. Outstanding flexibility. Copper foil optimally suitable for COF applications, as well as FPC applications requiring high precision and high flexibility.

Table 1 compares U-WZ foil with FO-WS, which offers the best flatness of any of our current products. It is characterized in that, compared to the existing FO-WS foil, the roughness of the polyimide adhesion surface is much less so that undulation is less.

With respect to visibility, the cast material using U-WZ foil has been evaluated as comparable in every respect to the metallized boards generally used in currently available COFs.

Another advantage of U-WZ foil is its outstanding flex resistance. Results of the IPC flexing test are shown in Figure 1.

Table 1 Characteristics of 9-μm foils.

Characteristic		Unit	U-WZ	F0-WS
Surface roughness of resin adhesion side	Ra	μm	0.11	0.32
	Rz	μm	0.60	1.21
Surface roughness of reverse side	Ra	μm	0.12	0.26
	Rz	μm	0.85	1.40
Tensile strength		N/mm²	339	313
Elongation		%	7.0	5.0

In terms of the number of repetitions to failure, U-WZ foil is superior both to F-WS foil, which has the best flexural resistance among our existing copper foils, and to rolled foil. Its suitability is thus not limited to COF, but also extends to FPC applications requiring high flexibility.

2. DT-GLD and DT-FLD Copper Foils for Build-up Boards

Features: Low connection resistance with respect to conductive paste; contributes to reducing the size and upgrading the functionality of boards for mobile phones etc.

DT-GLD is a double-side treated copper foil for use with multilayer wiring boards having all-layer IVH structure. Figure 2 shows the condition of the surfaces.

Multilayer wiring boards having all-layer IVH structure are manufactured by a method whereby micro via holes are formed by laser in the prepreg, filled with copper

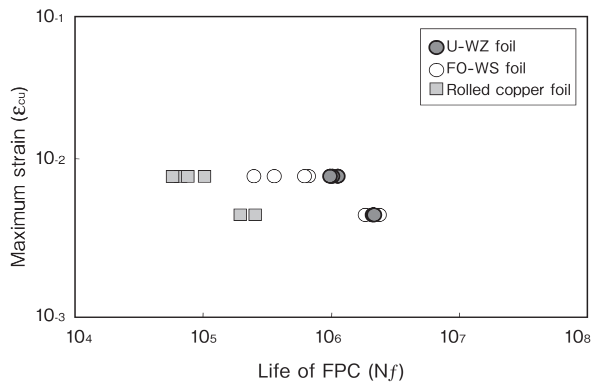

Figure 1 Flexural fatigue test results (taking flexural life as 110 % of initial resistance).

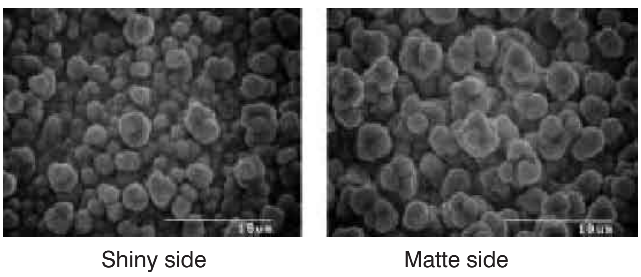

Figure 2 DT-GLD double-side treated copper foil.

paste which then hardens during lamination, and electrical connection between the desired layers is arranged by IVH. These are known as ALIVH †, and at present only our company's copper foil is used in this method.

Since this method uses copper paste to provide connection between layers, it is necessary to keep down the connection resistance between the copper paste and the copper foil. For this reason granular copper is electroplated onto both sides of the copper foil, reducing the connection resistance between copper paste and copper foil by means of the anchor effect.

Surface treatment that has dual-purpose of connection resistance reduction and corrosion prevention is also carried out, thereby effecting overall reduction in the connection resistance between copper paste and copper foil.

† ALIVH is a registered trademark of Matsushita Electric Industrial Co., Ltd.

3. FWL-WS Copper Foil for High Heat-Resistant Resins and High-Frequency Boards

Features: Strong adhesive force even with special resins where adhesion is hard to obtain. Highly suitable for high-frequency boards and liquid crystal polymer boards.

FWL foil is a copper foil developed based on WS foil (glossy on both sides) for liquid crystal polymer applications. Liquid crystal polymers have superior high-frequency characteristics, but on the other hand show a tendency to lower strength of adhesion to copper foil. In the case of liquid crystal polymers, the structural formula means that peel strength cannot effectively be raised by chemical bonding, so peel strength improvement was achieved using the anchor effect.

For the FWL foil, the matte surface treatment is differently configured from that of F2-WS, and despite the fact that its surface Rz is of the same order as F2-WS, it has a configuration with high peel strength. Table 2 shows these characteristics.

Figure 3 shows the relationship between frequency and transmission loss. From this it can be seen that FWL is a copper foil that combines high peel strength with outstanding high-frequency characteristics.

Table 2 Surface roughness and peel strength.

	Surface roughness (μm)	Peel strength (kN/m)
FWL	1.8 ~ 2.5	0.7 ~ 0.8
Standard foil (GTS-STD)	7.0 ~ 10.5	0.7 ~ 0.8
F2-WS	1.9 ~ 2.8	0.25 ~ 0.3

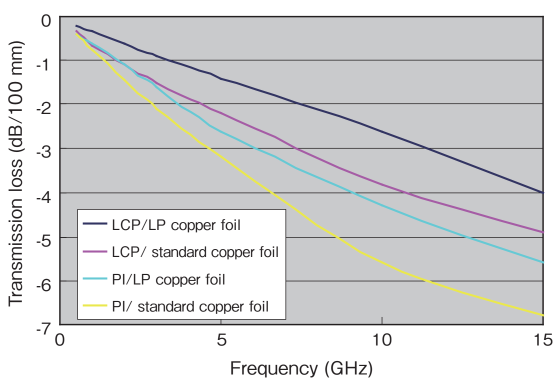

Figure 3 Results for transmission loss, without coverlay.
LP copper foil: FWL foil
(By courtesy of Japan GORE-TEX INC.)

4. U-HP and FWL-HP High Heat-Resistant Superthin Peelable Copper Foils

Features: A superthin (3~5 μm) copper foil that is peelable even after heating to 250~300°C, and can be used even with resins such as polyimide that are subjected to high-temperature processing.

We market F-WS foil as a copper foil for fine patterning applications, but 9 μm is its limit in terms of foil thickness, anything thinner being difficult for customers to handle. Given the objective of fine patterning, those with respect to requirements for which there is a limit with the subtractive method, a semi-additive method is adopted, whereby superthin foil is laminated onto a resin board, and onto this is applied a process comprising resist → plating → resist peeling → flash etching.

As a copper foil for this sort of application, we market F-DP foil, made by a process in which a peeling layer is provided on a carrier foil, onto this is formed a superthin foil of 3 to 9 μm, and, after lamination onto the resin board, the carrier foil is peeled off.

Since F-DP foil assumes laminating onto an epoxy resin board, peeling of the carrier foil and the superthin foil becomes difficult at laminating temperatures in excess of 220°C. We have therefore augmented our product lineup with high-temperature peelable U-HP and FWL-HP foils as superthin foils with carrier that can stand up to recent high-Tg package boards or polyimide boards that are cast or laminated at 300°C or more. Table 3 shows their characteristics.

5. FR-WS Copper Foil with Resistive Layer

Features: Has a 50~100Ω/□ characteristic capable of replacing resistance chip components, holding promise for reducing the size and improving the functionality of circuit boards.

A copper foil with resistive layer is a one with an electri-

Table 3 Characteristics of superthin peelable copper foils with carrier.

	Surface roughness of carrier foil (μm)	Peel strength of carrier when heated to 330°C (kN/m)
F-DP	1.2~2.0	Can not be peeled off
U-HP FWL-HP	1.2 or less 〃	0.02~0.03 〃

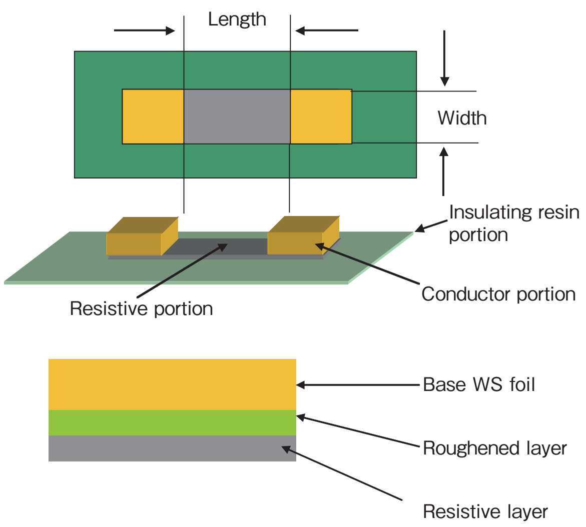

Figure 4 FR-WS copper foil with resistive layer.

cally resistive layer formed on the foil (see Figure 4). This makes it unnecessary to have an external resistor as is used with conventional boards.

The resistive circuit is formed by etching the copper and electrically resistive layer, followed by selective etching of the copper.

Since our copper foil with resistive layer uses F-WS foil as the base foil, it has outstanding properties not found in the foils of other manufacturers that make possible fine patterning and, with respect to flex resistance, make possible its use in FPC applications.

At present we have completed the development of copper foils with sheet resistance of 25 Ω/□ and 50 Ω/□, and have begun marketing them.

Concept of sheet resistance:

- Area of resistive material = sheet resistance of resistive material;
- Resistance value = sheet resistance x (length/width)
- Sheet resistance = resistance value / (length/width)

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