

May, 2020

Photo Imageable Cover layer Film

FLEXFINER-30EM-L

For DI exposure device

Technical Data Sheet

FPC Materials Dept.

 **TAIYO INK MFG. CO., LTD.**

Photo Imageable Cover layer Film FLEXFINER-30EM-L

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1. SPECIAL FEATURES

FLEXFINER-30EM-L is a photo imageable cover layer film to make fine patterns possible with photolithography process.

FLEXFINER-30EM-L offers excellent heat resistance and bendability because it consists of two layers with top cover layer and bottom adhesion layer. At the same time, FLEXFINER-30EM-L is photo imageable so that fine patterning is possible in the same way as with photo imageable solder mask. Compared to conventional thermal curable cover layer film, FLEXFINER-30EM-L does not require punching process with expensive metal mold.

Moreover, higher productivity and lower process cost can be achieved because of the simpler manufacturing process with FLEXFINER-30EM-L, while conventional FPC manufacturing process requires 2-step process, first punching and lamination process and second solder mask formation process.

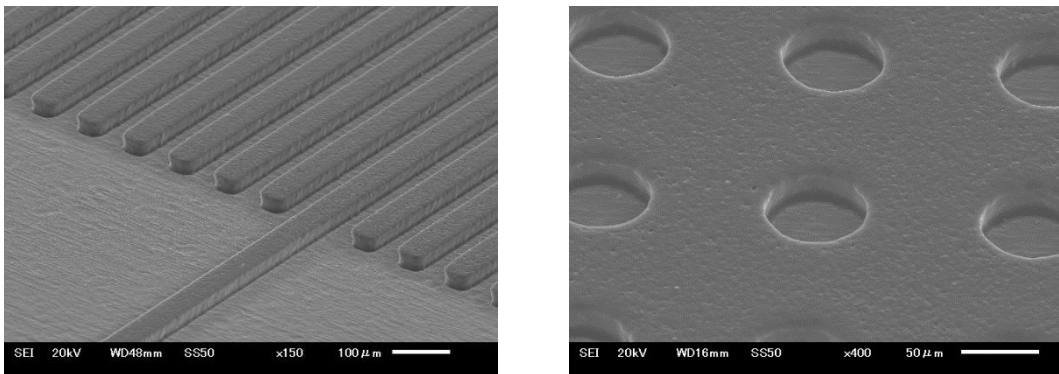
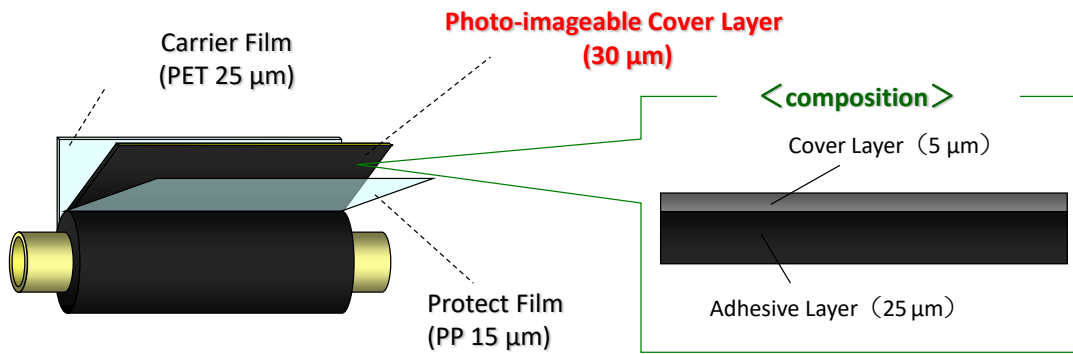


Fig. Formed pattern for Cu Pad (L/S = 50/50μm and φ 60 μm)

2. SPECIFICATIONS

| Item | Remarks |
|---------------------------|---|
| Color | Black(matte) |
| Supply form | Dry film Width: 247mm (provisional) Length: 50m (provisional) |
| Handling time limit at RT | 5 days (provisional) |
| Storage condition | -15deg.C or 5deg.C at dark place (provisional) |

3. FILM STRUCTURE



| Composition | | Thickness |
|-----------------------------|----------------------|------------------|
| Photo imageable cover layer | Polyimide derivative | 5 μm |
| | Epoxy derivative | 25 μm |
| Carrier film | PET | 25 μm |
| Protect film | PP | 15 μm |

4. PROCESS

The process of making the cover layer of FLEXFINER-30EM-L is shown in the following Fig. In process point of view, there is a difference from conventional photo imageable solder mask process. PEB (Post Exposure Bake) process after exposure is needed for excellent heat resistance and stable opening shape.

The recommended process conditions are shown below. Regarding PEB process, please refer to Appendix "PEB process" for further details.

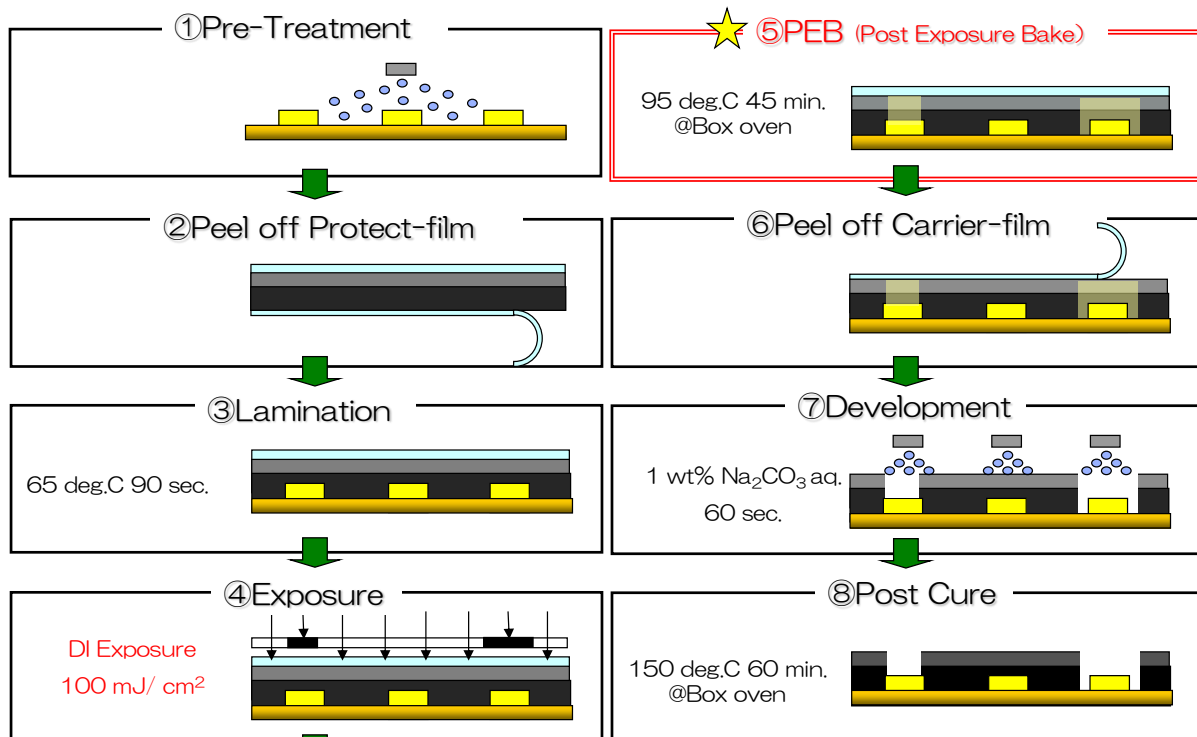


Fig. Forming process of photo imageable coverlay

| Process | Recommended conditions | Remarks |
|-----------------------------|--|---|
| Film thawing | >4 hrs. at 20~25deg.C | <ul style="list-style-type: none"> ● Thaw films at the temperature controlled between 20~25deg.C ● Take films out from box and thaw film without removing light-shield black film. ● After thawing, the films must be used within 5 days. The use of the film after 5 days might cause residues and/or development failure. |
| Pre-treatment | Acid cleaning | <ul style="list-style-type: none"> ● Remove waxes and oxidized surface ● Remove moisture completely after cleaning ● Chemical agent: MECBRITE CB-801Y (MEC COMPANY LTD.) |
| Lamination | <ul style="list-style-type: none"> ● Vacuum laminator Temp. 65deg.C(60~80deg.C) Vacuum Time: 20 sec. Press Time: 90 sec. Pressure: 0.4 MPa | <ul style="list-style-type: none"> ● Lamination temperature higher than 70deg.C may cause thinner thickness on copper and non-uniform color. ● Optimum lamination conditions depend on equipment, FPC size, and etc. ● Vacuum laminator (Carrier system type): <i>MEIKI CO., LTD. MVLP-500</i> |
| Exposure | <ul style="list-style-type: none"> ● DI exposure unit Energy: 100 mJ/cm² (80~120 mJ/cm²) ● Contact exposure unit (high pressure Hg short arc) Energy: 100 mJ/cm² (80~120 mJ/cm²) | <ul style="list-style-type: none"> ● Confirm the sensitivity with step tablet (Kodak No.2 21steps) at the exposure process. Recommendable sensitivity: Cover layer sensitivity: Step 4+/-1 Residual sensitivity: Step 9+/-2 ● Exposure on top of the base film ● Higher exposure energy could cause poor resolution. Lower energy could cause deterioration of cover layer properties, lift-off of fine pattern, and/or under-cut. ● DI exposure unit: Mms60 (ORC) ● Contact exposure unit: EXP-2960 (ORC) |
| PEB (Post Exposure Bake) | (Box oven) Temperature: 95deg.C (90~100deg.) Time: 45 min. (25~75 min.) | <ul style="list-style-type: none"> ● PEB process is necessary for excellent heat resistance, excellent gold plating resistance. Please refer to Appendix "PEB process" for more details. ● PEB time longer than 75 min. could degrade developability. PEB time shorter than 25 min. could cause deterioration of cover layer properties, delamination, and/or under-cut. ● PEB temperature higher than 95deg.C could degrade developability. PEB temperature lower than 85deg.C could cause deterioration of cover layer properties, delamination, and/or under-cut. ● PEB process condition should be within the window shown in the following Fig. on the next page |
| Removal of Carrier film | After storage at 20~25deg.C, before development (0.5~24 hrs.) | <ul style="list-style-type: none"> ● Peel carrier-film after storage at room temperature to cool substrate off after PEB process. Appearance defect would be caused by peeling without cooling-off. |

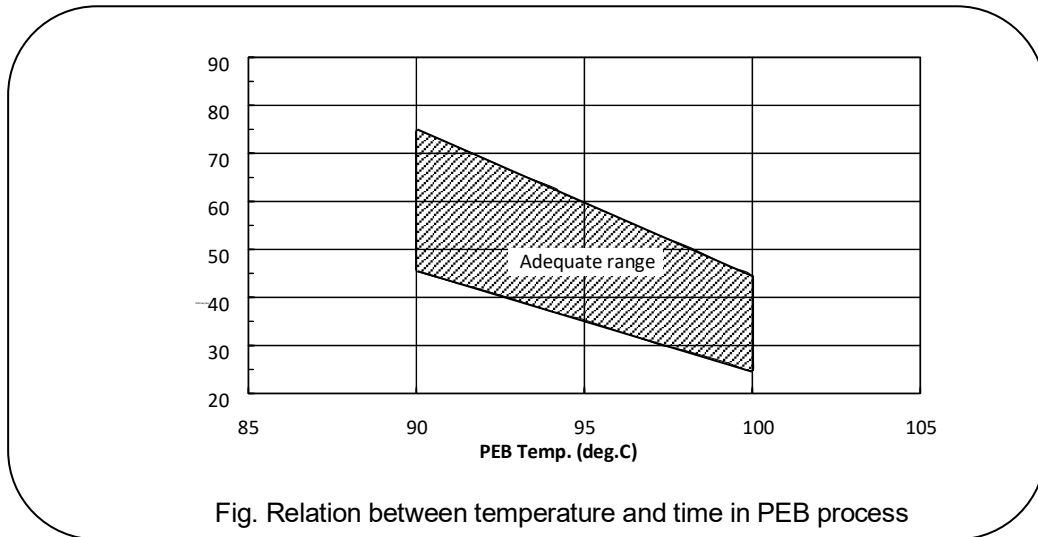


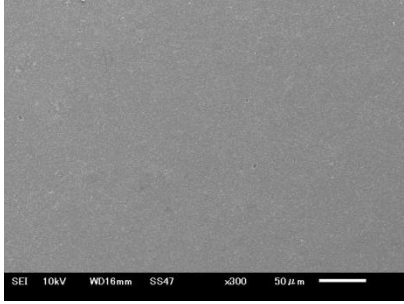
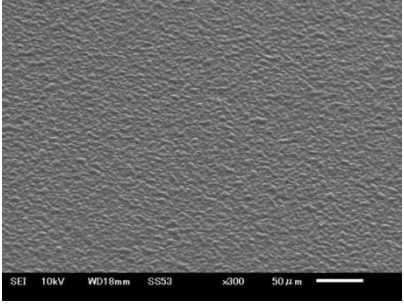


Fig. Relation between temperature and time in PEB process

| Process | Recommend condition | Remarks |
|-------------|--|--|
| Development | <ul style="list-style-type: none"> ● <u>Developing</u> Solution: 1wt%Na₂CO₃ aq. Temperature: 30deg.C Pressure: 0.1 MPa Time: 60 sec. (50~70 sec.) ● <u>Water rinse</u> Temperature:15~30deg.C Time: 0.5~1.5 times as developing time | <ul style="list-style-type: none"> ● When the developing time is less than 50 sec., it may cause poor resolution and/or residue. ● When the developing time is more than 70 sec., it may cause poor physical properties, poor ENIG resistance, under cut and /or delamination. |
| Post cure | <p><u>Box oven</u> 150deg. C / 60 min. (50~70 min.)</p> | <ul style="list-style-type: none"> ● Optimum curing process window should be considered together with legend ink curing time. Excess or short curing time may cause deterioration of final properties. |

APPENDIX "PEB PROCESS"

FLEXFINER-30EM-L consists of top cover layer and bottom adhesion layer. Composition of top cover layer is polyimide basis. Only with UV exposure, polyimide network is not sufficiently formed. PEB (Post exposure bake) is required after exposure process to make polyimide cured sufficiently.

| | Without PEB process | PEB process 95deg.C / 45 min. |
|---|---|---|
| Cross section view (image) |  <p>Dissolved cover layer by development</p> |  <p>Formed cover layer</p> |
| Surface of FLEXFINER |  <p>SEI 10kV WD18mm SS47 x300 50 μm</p> |  <p>SEI 10kV WD18mm SSS3 x300 50 μm</p> |
| Solder heat resistance 288deg.C /10 sec. | Blister | Pass |

As shown above, **formed pattern shape without PEB process is similar to it with PEB, but there is a tendency of surface changing to matte when PEB process is skipped.** This is because top cover layer is dissolved during developing process. In such case, solder heat resistance is also affected. Blister could be observed on the substrate after soldering test without PEB process.

To prevent this phenomenon, PEB process is required after exposure process. PEB process makes top cover layer of imide resin sufficiently reacted and formed. The cured film shows excellent heat resistance.

5. FINAL PROPERTIES

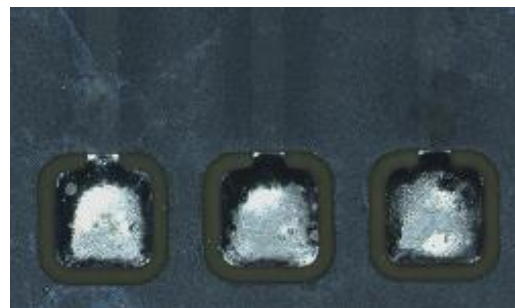
| Item | Test method | Result |
|---|---|------------------|
| Adhesion | TAIYO Internal Test Method Cross hatch/Tape peeling | 100/100 |
| Pencil hardness | TAIYO Internal Test Method No scratch on copper surface | 3H |
| Solder heat resistance (Dipping) | 288deg.C 10 sec. × 3 times | Pass |
| High heat resistance test (Hot bar) | 320deg.C 10 sec. × 1 times 350deg.C 10 sec. × 1 times | Pass |
| MIT test | L/S = 200/200 μm, R: 0.38 μm, Load: 4.9 N, Number of samples: 5 | 220~240 cycles |
| Bendability | TAIYO Internal Test Method 180deg. Bending | No crack |
| Flame retardance (TAIYO internal test) | UL-94 Kapton100H(25 μm), Double-sided | VTM-0 equivalent |

【Solder heat resistance】

288deg.C x 10 sec x 3 times

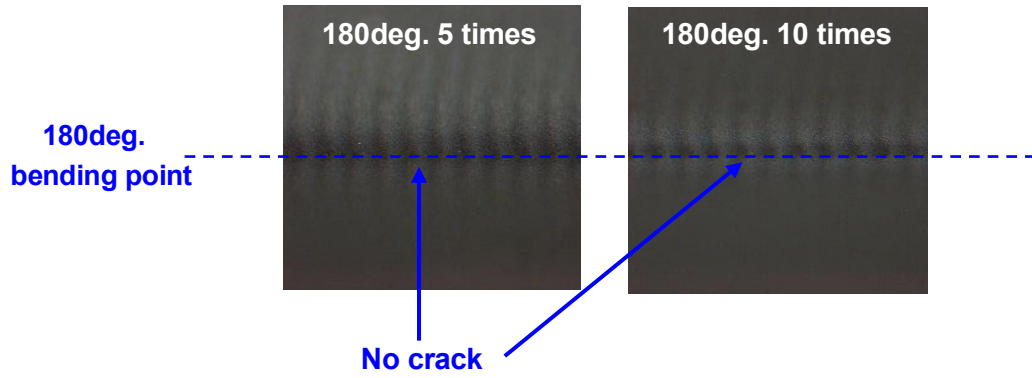


288deg.C x 10 sec x 3 times



Base material: FELIOS R-F775 (PI: 25 μm, Cu: 18 μm, *Panasonic*)
Fig. Surface observation after solder heat resistance (288deg.C 10 sec. × 3 times).

【Bending test】



Base material: Espanex M(PI: 25 μm , Cu: 24 μm)
 Circuit: L/S = 200/200 μm
 Load: 1 kg

Fig. Surface observation after 180deg. bending test

【Chemical resistance】

| Item | Test method | Result |
|---------------------|--|-------------------------------------|
| Solvent resistance | Solvent: PGM-AC 25deg.C / 20 min. Immersion, Cross hatch/Tape peeling | Pass No blister, no delamination |
| Acid resistance | Acid: 10 vol% H ₂ SO ₄ aq. 25deg.C / 20 min. Immersion, Cross hatch/Tape peeling | Pass No blister, no delamination |
| Alkaline resistance | Alkaline: 10 wt% NaOHaq. 25deg.C / 20 min. Immersion, Cross hatch/Tape peeling | Pass No blister, no delamination |
| ENIG resistance | ENIG Au: 0.1 μm , Ni: 4.0 μm | Pass No blister, no delamination |

【ENIG test】

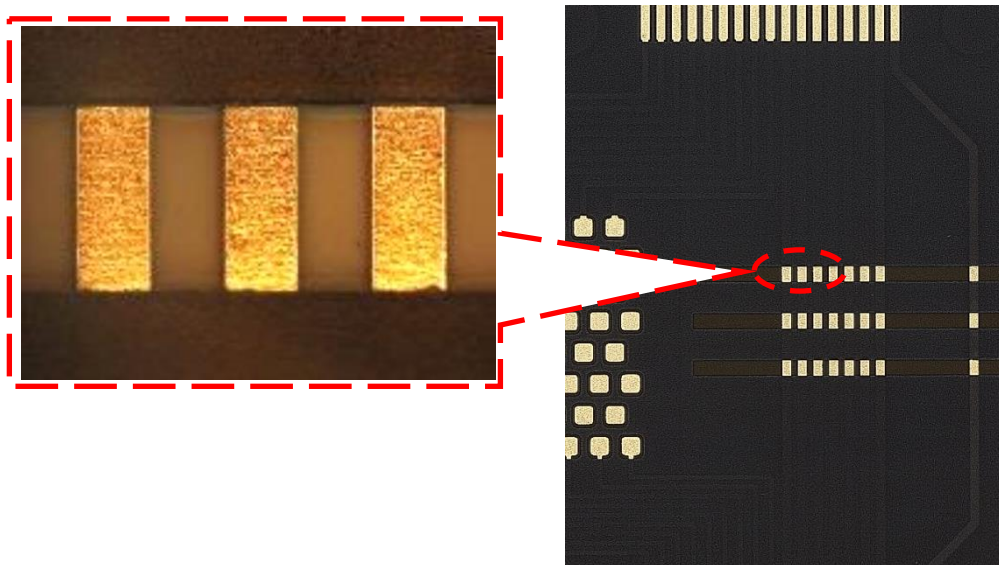


Fig. Surface observation after ENIG test

【Mechanical and physical properties】

| Item | Test method | Result |
|-----------------------|---|--|
| Tensile test | Tensile testing machine <i>SHIMADZU</i> : AGS-G 100N | Young's modulus: 1.6GPa Tensile strength: 22 MPa Breakdown elongation: 28% |
| TMA | Thermal mechanical analyzer <i>SII</i> : TMA/SS6100 | Tg1: 39deg.C Tg2: 173deg.C CTE α_{1AD} (0~20deg.C): 83 ppm CTE α_{1CV} (100~120deg.C): 90 ppm |
| Insulation resistance | IPC Comb type, B pattern 100V, 60 sec. | $5.88 \times 10^{13} \Omega$ |
| | IPC Comb type, B pattern 500V, 60 sec. | $3.60 \times 10^{13} \Omega$ |
| Breakdown voltage | JIS C 2110 | Above 4.2 kV/mil (Above 5.0 kV/ 30 μ m) |
| Dielectric property | Cavity resonator perturbation method (1 GHz) | Dielectric constant: 3.10 Dielectric factor: 0.02 |

*All test data in this technical data sheet are based on our laboratory test results and just for reference.
We cannot guarantee the same results on your process.

6. CAUTION

All chemicals used in this product might have unknown toxicity. Please handle with your most care referring to the MSDS for use.