Technical Trends of Advanced Two-Layer Flexible Copper Clad Laminate

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Flexible circuit boards (FPC) are widely used in modern electronic technologies, with downsizing being a constant trend. Copper Clad Laminate (CCL) materials are the basis for FPCs. Made of copper foil and polyimide resin, CCLs present one of the most important applications for polyimides.

CCLs have traditionally been produced as three-layer stacks, consisting of a copper foil layer coated with an epoxy adhesive which is then coated with polyimide. However, increasingly stringent requirements have been placed on the pattern pitch of features contained on CCLs as a result of their use as mobile phone hinges, and in semiconducting packaging.

Therefore, non-adhesive two-layer CCLs with high dimensional stability, good bending performance, and high thermal stability are in ever-increasing demand.

Nippon Steel Chemical has been in the CCL market since 1986, employing a two-layer technology manufactured by casting of polyimides originally designed and produced in-house. Improved polyimides as well as CCLs have been recently required for use in high-performance mobile devices and LCD televisions.

In this lecture, we report the required properties of polyimides for use in CCLs, in addition to the leading-edge development trends of two-layer CCLs produced by the casting method.

Content of this presentation

- Market trends of FPC and CCL
- Required properties of polyimides for CCL
- Comparison of properties between two- and three-layer CCLs
- Characteristics of two-layer CCLs as they depend on production method
- Features of two-layer CCLs made by the casting method
- Leading-edge development trends in two-layer CCLs

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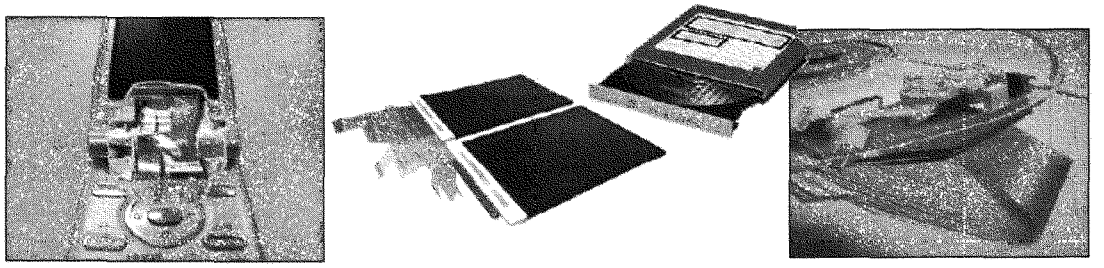
What is the Flexible Printed Circuit ?



- Made of copper foil and resin film (polyimide)
- Present thin and foldable printed-wiring board
- Widely used as foldable parts such as portable devices (wiring), printer component

■FPC History

➢At the end of 60's, FPC was developed for military applications (aircraft, aerospace) in the US.

➢At the end of 70's, FPC was used as the component of the camera. And then, FPC was widely used in modern electronic technology, such as PC related devices and portable appliances.

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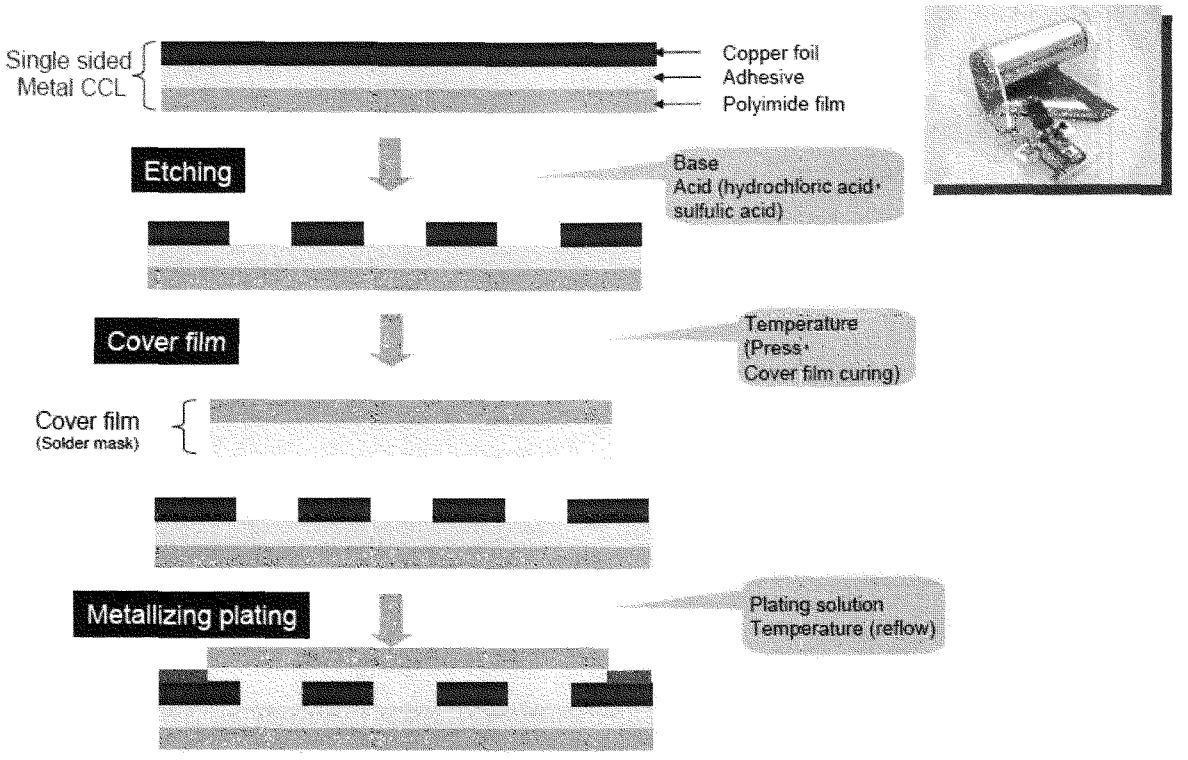
FPC Working Process



Two-layer CCL by casting : Point of view

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■Three-layer CCL; PI , adhesive (epoxy, acrylic), Cu foil, does NOT show high dimensional and thermal stability

■Remove adhesive from FPC

■Cu foil is coated with PI directly, which is then dried and cured

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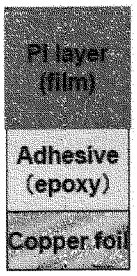

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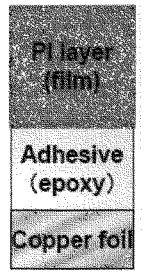

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Two-layer CCL Process

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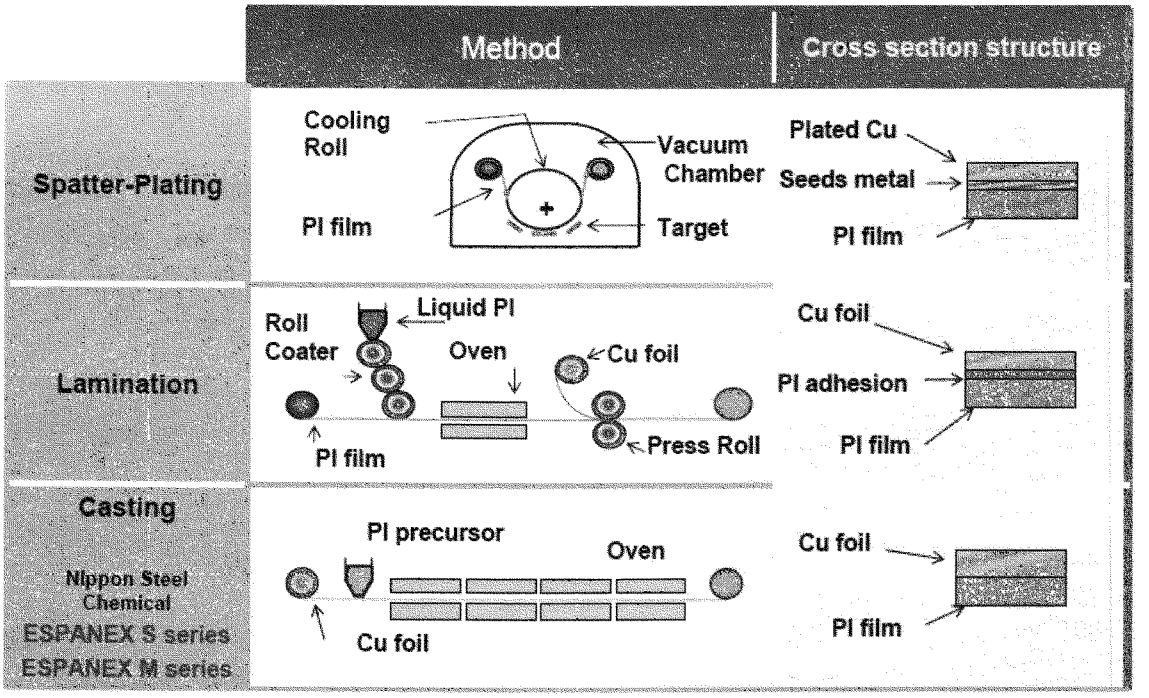

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Comparison on Adhesive-less CCL

	Casting	Spatter-Plating	Lamination
PI selectivity	◎ Original PI	○ Commercial PI film	○ Commercial PI film
Cu selectivity	◎	△ Electrolytic plating Cu	◎
Cu thickness control	△⇒○ Thin Cu : available	◎ Thin Cu : easy △Thick Cu : expensive	○
Pinhole (Cu)	◎	△	◎
Adhesive initial stage (after heating)	◎(○)	○(△)	◎(○)
Fine pitch	△⇒○ Plain finished copper foil	◎	△
Dimensional stability (anisotropy)	◎	○	○
HHBT (Anti-migration)	◎	○	○
Heat resistance	◎	◎	△
Price	○	△	◎

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Advantage of ESPANEX M series

1. Excellent heat resistance
2. Low CHE (Coefficient of Humidity Expansion)
3. Excellent folding endurance
4. Excellent dimensional stability in circuit manufacturing process

Dimensional Change by moisture absorption

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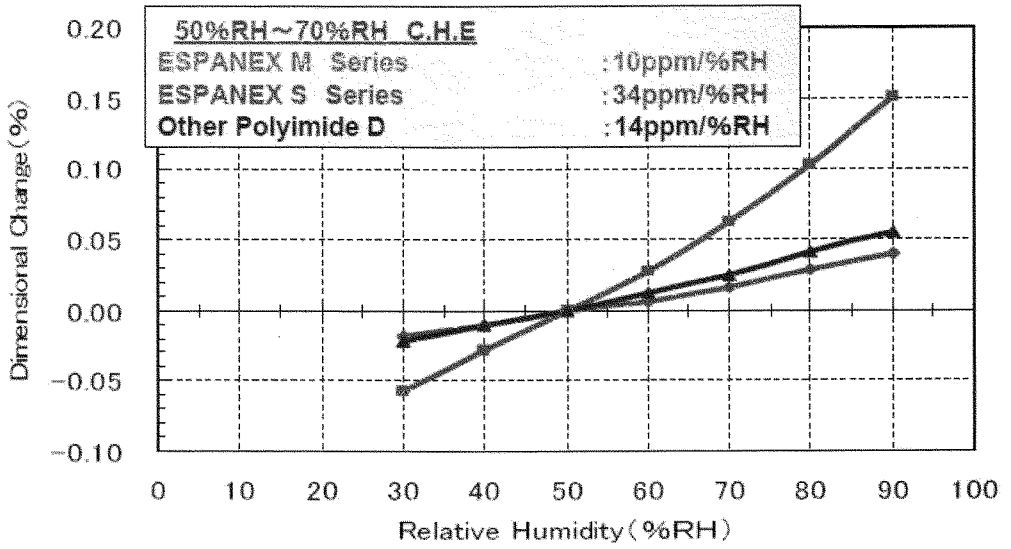

＊1 Copper foil is removed by etching before the test
ESPANEX® M Series :MC18-25-00FRP Copper 18μm / PI 25μm
ESPANEX® S Series :SC18-25-00FRP Copper 18μm / PI 25μm
Spattering material :Copper 8μm / PI 38μm Spattering type

Direction for Development

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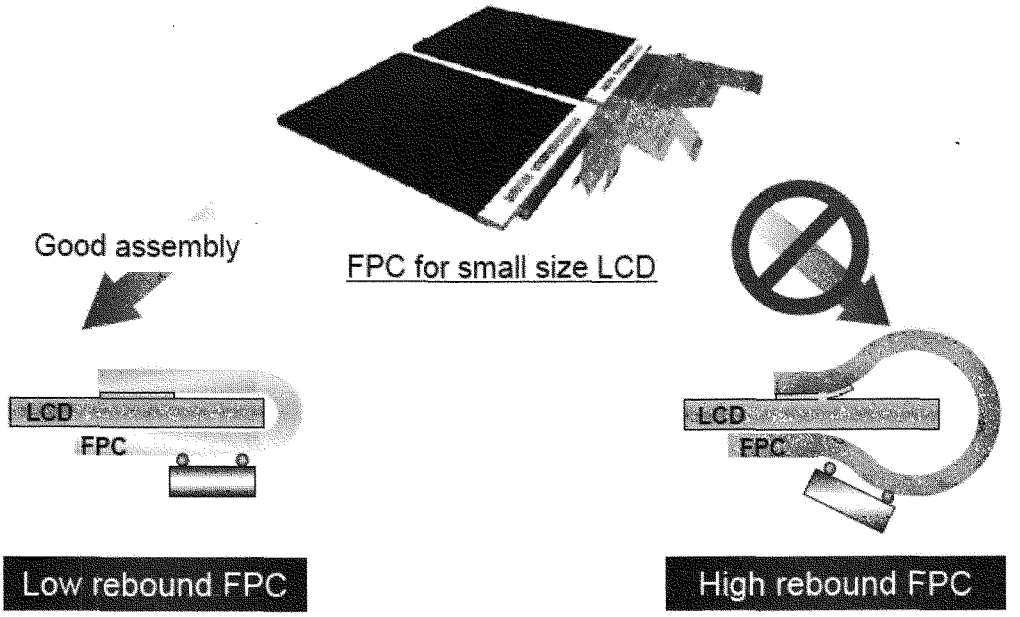
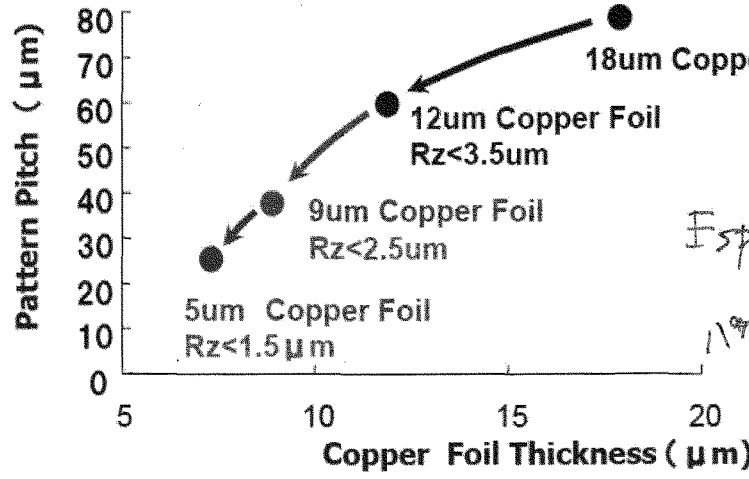
Market Demands		Material properties
High density	Fine pitch	・Copper foil thickness⇒Thin ・Plane Finish Cu Foil
Downsizing	Good bending performance	・Copper foil ⇒Good bending performance
	Low stiffness (space saving、energy saving)	・Polyimide thickness ⇒Thin
High speed	High-speed transmission (impedance matching)	・Polyimide ⇒Low coefficient of elasticity ・Low dielectric constant resin ・Polyimide thickness ⇒Thick

Necessity for Low Rebound FPC



Copper Foil Thickness for Fine Line Capability



Espanex-M;

パワーエレクトロニクス用途は?

for
Prevent Cu Residue

Surface Effect
(high Frequency application)

フレキの圧着の場合は
十分薄いので、面内方向
の熱伝導性のみ
厚み方向は問題にならない。

フレキの場合、要求パフォーマンスが
☆X-Y方向の熱伝導性 ←向上させる