SUMITOMO ELECTRIC
Ingenious Dynamics

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Sumitomo Electric Develops FPCs with Excellent Heat Resistance

Ensuring long-term reliability at 150°C by using a new adhesive material

Sumitomo Electric Industries, Ltd. has developed flexible printed circuits (FPCs) with significantly improved long-term reliability in the environment of 150°C or higher (up to 175°C) and started shipment of sample products. This achievement is attributed to the enhancement in insulator film adhesion and inter-circuit insulation performance by improving the adhesive material contained in the FPCs.

FPCs are primarily used in electronic devices including mobile devices. In recent years, FPCs have been widely used even in LED lamps and in-vehicle products due to its thinness, flexibility and component-mountable fine-pitch circuits. While the service temperature of FPCs for electronic device applications is generally 100°C or less, those used in lighting and in-vehicle applications are required to have high heat resistance of 100°C or more in many cases.

In the case of conventional FPCs, constituent materials are subject to
aging degradation especially if used in a high temperature environment at 150°C or more, resulting in significant loss of adhesiveness of insulator films. Sumitomo Electric has succeeded in significantly enhancing the basic performance in a high temperature environment (durability in a high-temperature and high-humidity environment) by improving heat resistance of the adhesive (one of constituent materials).

The newly developed FPCs are applicable to powertrains*1 in vehicles and LED lighting equipment relay cables (where high-temperature reliability is required), and component-mounting circuit boards. Sumitomo Electric will promote sales in these areas to help customers enhance design flexibility by using the FPCs as wiring materials, achieve reduction in size and weight of electronic components, and increase reliability and durability.

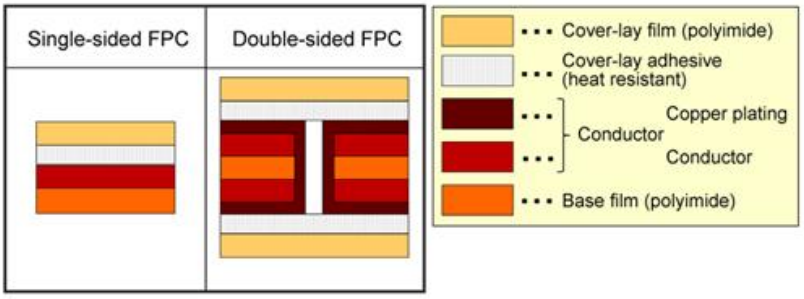

Figure1: Cross section of heat-resistant FPCs
(Single-sided / double sided FPCs)

【Outline of FPCs】

Printed circuit boards (FPCs) are flexible and foldable, and allow mounting of components. Notably, FPCs enable three-dimensional wiring in small spaces. Thus, FPCs have been increasingly used in small electronic

devices such as mobile terminals, HDDs, DVD drives, and game consoles.

FPCs are available mainly in two different structures: single-sided FPCs (having single-layer conductors) and double-sided FPCs (having double-layer conductors) (Fig. 1).
In FPCs, insulator films (base film: polyimide film, cover lay film: polyimide film and adhesive) are used to electrically insulate conductors (copper foil and copper plating). The newly developed FPCs are characterized by enhanced long-term reliability in a high-temperature environment by improving the cover-lay film adhesive.

【Features of the new FPCs】

In electronic devices, the operating environment is less than 150°C, and thus, conventional FPCs use adhesive materials made from epoxy and acrylic resins as cover lay film adhesives. However, when used in an environment at 150°C or more, the adhesive materials deteriorate, resulting in significant loss of adhesiveness and insulation performance (Table 1).

Table 1: Adhesive strength in a high temperature exposure test (150°C)

Test condition	Conventional product	Newly developed product
150°C × 3,000 hours	0.1 N/cm (NG)	> 5 N/cm (OK)

(JPCA standard: cover lay film adhesive strength measuring 3.4 N/cm or more)

Containing new heat-resistant polymers, the newly developed adhesive material helps minimize deterioration in a high temperature environment, significantly improves the basic performance of FPCs, and mitigates the performance deterioration of insulator films.

We conducted durability tests in high temperature environments*2 to perform evaluations on (i) high temperature storage at 150°C in the atmosphere (Table 1), (ii) wet heat storage at 85°C/85%RH*3 (high temperature and high humidity), and (iii) immersion storage in oil at 150°C. We confirmed that, in all of these evaluations (in the initial conditions and after 3,000-hour storage), the cover lay film adhesive strength (JPCA standard, 3.4 N/cm or more) required of FPCs is guaranteed.

*1: A system that transmits driving force from a power source, such as an engine, to terminal parts through gears and shafts.

*2 : In the automotive cable standard (ISO 6722), the heat resistance standard ranges from Class A to Class H. The temperature resistance to 150°C is equivalent to that of Class D. As regards a long-term heat aging test, there is the following description: "Test pieces shall be left in a rated temperature environment for 3,000 hours, and shall be checked for damage in the insulation layer in a coiling test." No such heat resistance standards have been established for FPCs. As a reference, durability tests are conducted in accordance with Class D (as described above) at 150°C ×

3,000 hours.

*3: Relative humidity (HR) is the ratio of the amount of water vapor in an air-water mixture to the saturated vapor density at a prescribed temperature.

【Outline of Sumitomo Electric Printed Circuits, Co., Ltd.】

Business	Development and manufacture of FPCs for electronics products
Head Office	30 Hinokigaoka, Minakuchi-cho, Koka, Shiga, Japan
Representative	Junichiro Nishikawa (President and Representative Director)
Established	April 2000
Capital	1.5 billion yen (100% owned by Sumitomo Electric)