

Dry Film Resists for Fine Line and Space Patterning, “RY-5100UT series”

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1 Abstract

Photosensitive dry film resist has been used for circuit patterning in the printed wiring board (PWB) of various devices such as smartphones and central servers. To address the need for information processing at higher speeds and of larger volumes of data, we need to mount higher-performance PWBs in electronic devices by using finely patterned circuits.

The RY-5100UT-series photosensitive dry film for fine line and space patterning that we developed improves upon conventional photosensitive dry films.

RY-5100UT enables circuit patterning of 2 μm resolution on full-size PWBs. We expect that demand for RY-5100UT will increase in the future, as the need for ever smaller, thinner, and higher-performance electronic devices grows.

2 Characteristics of the Product

- The developed product exhibits excellent adhesion to substrates, and offers superior resolution and resist patterning.
- Few resist tails are generated, helping to reduce the undercut of the plating line.
- The developed product is compatible with projection exposure machines that use light sources with wavelengths of 355 nm.

3 Background of the Development

Semiconductor package (PKG) substrates are a type of printed wiring board mounted on electronic devices, such as smartphones and central servers. PKG substrates play an important role as the intermediate layer that connects the IC chips that process information to the PWB side. To address the need for increased information-processing capacity in recent years, the wiring of IC chips is becoming more and more miniature. Relative to the miniaturization of IC chips, the miniaturization of wiring for PWBs and PKG substrates has been slow, and the loss of energy due to differences in circuit widths has reached a level that can no longer be ignored.¹⁾ To address this problem, PWB manufacturers have developed new PKG substrates with different structures. However, because it was necessary to significantly reduce the width of conventional circuits, the use of a liquid resist (which had proven results when used in wafer-level packages) as the resist for circuit patterning has become mainstream.²⁾ Still, it is difficult to evenly apply a liquid resist to large panels. Furthermore, developing solutions and stripping solutions have never actually been used by conventional PWB manufacturers, and liquid resists require the use of expensive organic materials. For these reasons, there is strong demand for a photosensitive dry film that allows, as much as possible, the continued use of existing equipment and chemicals.

In light of this situation, we began developing a photosensitive dry film that enables the patterning of fine circuits.

4 Technical Details

Semiconductor package substrates are usually manufactured by using the semi-additive process (SAP) method.³⁾ **Figure 1** shows a diagram indicating the circuit width. Although the circuit pitch of a conventional semiconductor PKG substrate is 20 μm , the new package structure that uses fine circuit patterning requires circuit patterning with a pitch of between 4 μm and 10 μm . To respond to such rapid miniaturization, we developed the RY-5100UT series, which adopts a new hydrophobic material that effectively suppresses expansion caused by sodium-carbonate developing solutions. We also identified a photosensitizer suitable for high-resolution projection exposure machines and the optimum exposure region. The properties of the RY-5100UT series are listed in **Table 1**.

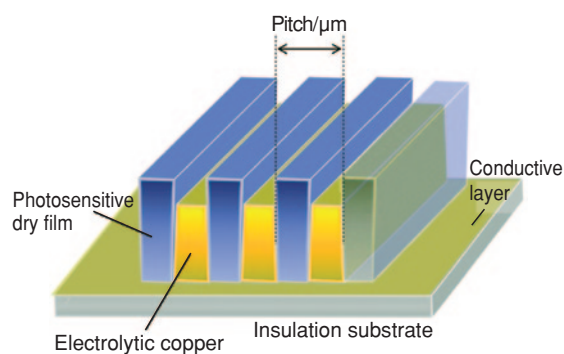


Figure 1 Pitch of the circuit width

Table 1 Properties of the RY-5100UT series

Item	Unit	RY-5110UT	RY-5107UT
Exposure machine	—	Projection exposure machine	
Resist film thickness	μm	10	7
Developing time	s	10	7
Amount of exposure	mJ/cm ²	200	200
Minimum circuit pitch	μm	6	4

Note: Recommended exposure machine, twice the minimum developing time, projection exposure machine: UX-44101SM-XJ01 (Ushio, Inc.)

Usually, when a fine circuit is patterned by using the SAP method, a projection exposure machine is used. Because a direct exposure machine or collimated light exposure machine is often used for conventional photosensitive films³⁾, these exposure machines must be matched to the projection exposure machine. By designing a resin that controls the photo-curing reaction, we were able to improve the reactivity and adhesion between the resist and the substrate interface. **Figure 2** shows a model of the photo-curing reaction.

By improving the reactivity and adhesion, the deformation of resist during plating deposition was reduced. Thus, we achieved a minimum circuit pitch of 4 μm after flash etching. **Figure 3** shows the results after plating and flash etching.

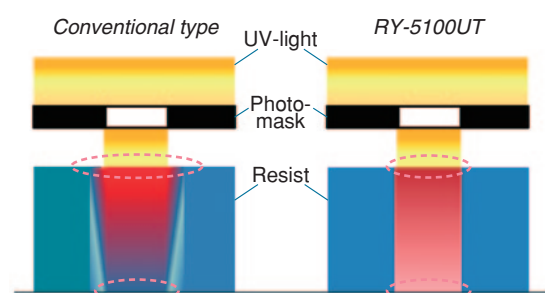
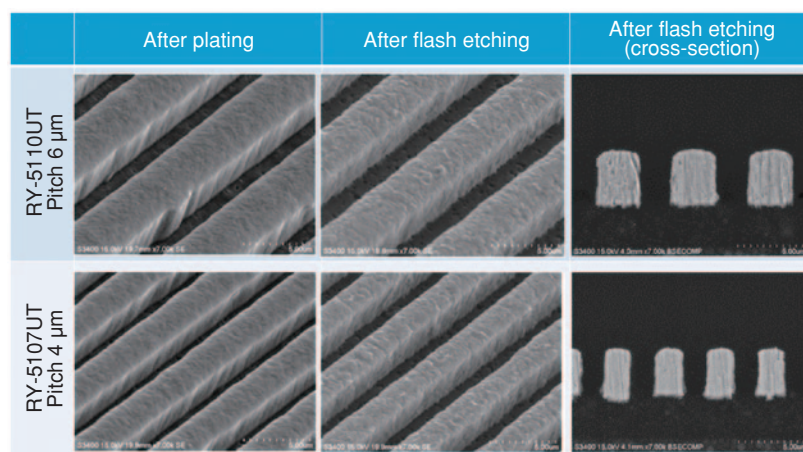


Figure 2 Photoreaction models for dry films for fine line patterning and space patterning



flash-etching solution : SAC (JCU CORPORATION)

Figure 3 SEM image of copper pattern after plating and flash etching

These results indicated that the RY-5100UT series offers both high resolution and high adhesion on a substrate and can be used to create fine resist patterns. As a material that can accommodate further miniaturization (which is expected to continue in the future), we believe that this new product will be useful in miniaturizing electronic devices and in improving the performance of such devices.

5 Future Business Development

- Further improvement of miniaturization ability of the photosensitive dry film.
- Expansion of the range of applications of the photosensitive dry film for fine circuit patterning.

【References】

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