

# The Basics of Dry-Film Resist

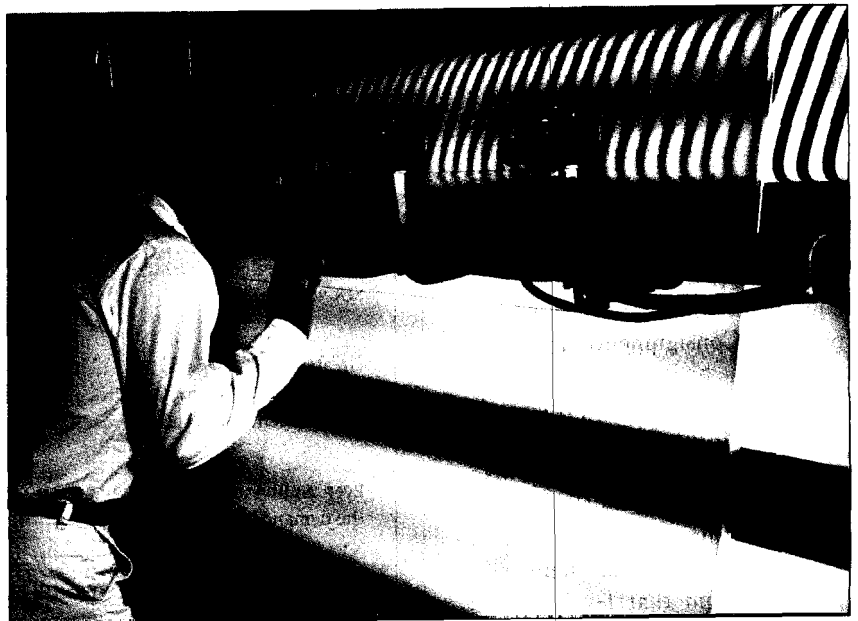
Its advantages are common knowledge, but what are its origins?

George Funk

Resists perform an important function in PCB fabrication: They enable circuit patterns to be formed. And anyone who has been following the electronics industry over the last several decades knows that those circuit patterns are becoming increasingly complex. Line widths of 3 to 4 mils are common, and they are expected to shrink in the coming years to meet the demands of sophisticated telecommunications and consumer applications.

Users of dry-film resist have converted from a norm of 8- to 10-mil lines and spaces (at which level this material maintained feature integrity even in the presence of dirt and imperfections in the coating process) to a new standard of 4- to 6-mil lines. To respond to these customer requirements, continuous improvements must be made in the dry-film manufacturing process.

Uniform coating is key to the effectiveness of dry-film resists. The resist manufacturer supplies material with precisely controlled coating thickness. Several methods ensure this uniformity, including continuous monitoring of resist thickness that uses on-line instrumentation such as beta radiation gauges, and scanners that make hundreds of measurements per minute.



Towanda coater operator Greg Williams sets film inspection cameras.

## Building Blocks

Dry-film resists are usually supplied to customers in rolls ranging from 2" to 60" wide and 125' to 1,000' long. A typical roll is 18" X 500' and 1.5 to 2 mils thick.

The appropriate thickness depends on the function the resist must perform. If it is to be used as an etch resist, an 18-um-to 38-um-thick material is needed. If it is to be used in plating, a 38-um to 50-um material allows the manufacturer to take advantage of the high perpendicu-

lar sidewalls of the film. For special applications, where conductors more than 50 um thick must be plated or large holes tented, a 75-um resist will be more reliable. This is also the case when phototaping is used to manufacture high-quality gold edge contacts. Super-thin resists, measuring less than 1 mil, fulfill computer applications' need for ultra-high resolution.

The structure of the resist is simple. It starts with a base of polyester film. Many manufacturers

use Mylar polyester film, a new grade of which was recently developed with special photographic qualities for the photoresist industry.

The PCB maker retains the polyester sheet throughout the exposure process to protect the photopolymer layer from contamination. The sheet holds the resist in place and keeps the phototool from sticking to the resist. The polyester sheet

eters, and components that give the resist different physical and performance characteristics. These include rapid processing, tenting, and adhesion to various substrates.

### Quality of Ingredients

The quality of the resist ingredients—specially the polymers and the monomers—can impact the ef-

posed to resists that must be developed with 1,1, 1-trichloroethane and stripped with methyl chloride—two ozone-depleting chemicals typically used for solvent-processable resists—the new aqueous-processable resists can be developed using a 1% sodium carbonate solution and stripped with a 1% sodium hydroxide solution.

The final ingredient of dry-film resist is a sheet of polyethylene, which is laminated to the coating after that coating dries. In the case of extrusion coating, lamination occurs immediately after the application of coating to the Mylar base. This polyethylene cover sheet protects the photopolymer layer during transit and storage, keeping the tacky resist from sticking to itself. The cover sheet is removed before the resist is laminated to the printed circuit board.

Most polyethylene film is manufactured under demanding conditions and used in applications such as agricultural plastics or in harsh environments such as construction. But dry film is a more exacting application, and a polyethylene sheet with high photographic quality provides superior results for electronics applications.

### The Future of Dry-Film Resist

The health of the dry-film industry rests not only on manufacturers but on the extent to which those along the supply chain work together. Interlining between the raw materials supplier, dry-film manufacturer, fabricator, and assembler will drive consistency, reduce cycle time and costs, and improve quality. Environmental friendliness and quick product turnaround will also be important selling points for all resist suppliers in the years to come. **FAB**

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James Hoffmann, Towanda laboratory technician, tests for solubility.

is removed immediately before the development stage, when the image that must remain on the panel has been fully hardened by exposure to UV light.

A photosensitive liquid is applied to the polyester base. The liquid usually contains materials dissolved in a solvent. There is also a proprietary solventless system that's extruded onto the polyester film. The solvent serves as a carrier for the active ingredients: polymers, the "backbone" of the structure that imparts physical strength and determines whether the resist will be aqueous or solvent processable; and photosensitive monomers, which polymerize when exposed to UV light, changing from a soluble to an insoluble form. Typical resists contain 10 to 20 ingredients, including dyes, adhesion pro-

tectiveness of the imaging process. The dry-film manufacturer should work closely with its suppliers to, first and foremost, design the materials with end use properties and the coating process in mind and to certify the quality of their materials. Liquid chromatography, thermal analysis, and other analytical techniques can be used to confirm the purity of these raw materials.

Numerous liquids are used in dry-film resist manufacture depending on the grade of the material. These liquids have the same basic structure, but vary in the way they're processed. The three major types of resist are solvent processable, semiaqueous processable, and fully aqueous processable. Environmental concerns have steered most resist manufacturers and users to fully aqueous-processable resists, As