History and Technology of Photopolymer Printing Plates

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A printing system has four independent components: a press, an image carrier, ink and paper or other substrates to carry a message. The image carrier is the printing plate in traditional printing processes. The processes in which photopolymer plates are used to carry ink and transfer it to the substrate are lithography, flexography, letterpress and gravure.

The first synthetic photopolymer for imaging applications was patented (US Patent 2,610,120) by Louis Minsk et al of Eastman Kodak in 1952. The invention was entitled "Photosensitization of Polymeric Cinnamic Acid Esters". The photopolymer was essentially a photoresist based on polyvinyl cinnamate. The chemistry was also used to make photoengravings and lithographic plates.

Letterpress Plates

In letterpress printing, the face of image elements is in relief, i.e., it is raised above open areas. The plates are rigid and utilize oil-based viscous inks. Historically, cast letters or types were set in a frame, inked and used in a hand-press for printing. Later, zinc and copper-based metal engravings as well as lead-based stereos were used as letterpress plates.

The first photopolymer-based letterpress plate is believed to be developed by Time Inc. and was used by them in 1957 for magazine printing. This plate, called Tilon, was based on nylon chemistry. In 1960, DuPont came out with acrylic-based Dycril. Dycril remained in production through 1970s. Tilon gave way to an improved polyamide plate called Nyloprint introduced by BASF of West Germany in 1968. It uses alcohol solution for development.

The need to replace alcohol led to development of aqueous-developing nylon-based relief plates. This development initially came from Japan with introduction of Torelief plate (1977) from Toray Industries, Miraclon from Tokyo Ohka Kogyo and Printight (1977) from Toyobo Co. BASF also later came out with water-washable plates. These nylon-based relief plates are still widely used today in commercial printing which also includes dry offset printing wherein an intermediate blanket cylinder transfers the image from a curved shallow-relief plate to a substrate. However, these plates were expensive for use in newspaper printing. In 1970, Japan's Asahi and W.R. Grace of U.S.A. introduced liquid photopolymers for newspapers. Nippon Paint of Japan also developed a lower cost solid plate based on polyvinyl alcohol chemistry and it was introduced in the US as Napplate in 1973. The last one is still used by some newspapers today.

Flexographic Plates

Flexographic plates are relief plates with image elements raised above open areas. They are elastomeric in nature in contrast with hard letterpress plates discussed earlier. They use low

viscosity inks. Flexographic plates have a Shore A durometer hardness of 25-55 versus durometer readings in excess of 60 for letterpress plastic plates. Most elastomeric plates, other than photopolymer plates, are made of either natural or nitrile rubber of various hardness.

During 1960s and 1970s, all the major companies in the field were also trying to develop photopolymer-based solid flexographic plates. One of the earliest patents covering elastomeric patents is US Patent 3,024,180 of William McGraw assigned to DuPont in 1962 with compositions based on polychloroprene rubber. DuPont introduced the first solid photopolymer flexographic plate under the trade name Cyrel in 1974, believed to be based on styrenic elastomers. This was followed by Uniroyal's Flex-Light plate in 1975. The U.S. Patent 4,264,705 assigned to Uniroyal in 1981 describes a multilayer structure including a relief layer based on nitrile rubber and an elastomeric backing layer both photocured to desired hardness.

Tokyo Ohka Kogyo of Japan introduced a flexographic photopolymer plate under the trade name Elaslon in 1975. Napp Systems introduced Nappflex flexographic plates for newspapers in 1977. Goodyear Tire and Rubber had introduced liquid photopolymer system under the trade name Phasar in 1977. The Phasar technology was acquired by Hercules in 1980. B.F. Goodrich had introduced flexographic plate under the trade name Econo-Etch which was withdrawn from the market in 1979. BASF's Nyloflex came into the market in 1979. Toyobo of Japan introduced flexographic photopolymer plate under the trade mark Cosmolight in 1990. Supratech Systems, a subsidiary of Nippon Paint in the U.S., introduced aqueous-processed flexographic plates under the trade name Flaxceed in 1992. Earlier Nippon Paint had introduced a solvent-processing flexographic plate in Japan in 1976 under the brand name Runaflex which was discontinued in 1984.

In 2002, DuPont introduced Cyrel Fast technology to eliminate use of solvents in plate processing. Here, the plates after exposure are developed by removing the unexposed photopolymer by melting it away and absorbing it in a medium.

Lithographic Plates

Lithography, also known as offset printing, utilizes a plate with a flat printing surface. A dampening system wets the plate surface in non-image areas to repel the ink. Oil-based ink is used to wet the image areas. The ink is transferred, or offset, from the plate to a rubber blanket and then to the substrate.

In lithographic printing, diazo plates were in vogue in 1960s and 1970s with 3M dominating the market. The first photopolymer plate was introduced by DuPont in 1967 under the trade name Lydel. This was followed by Eastman Kodak and Polychrome Corp. As mentioned in the beginning, Eastman Kodak patented the first photopolymer in 1952 which found applications in photoresists and also in lithographic printing plates. Eastman Kodak introduced its photopolymer-based lithographic plate in 1969 under the trade mark Polymatic. Polychrome also came into market in 1969 with its Fotomer plate.

Howson-Algraphy, a subsidiary of Vickers of England, started marketing photopolymer plates in 1973 under the brand Visiplate and Marathon. 3M introduced its photopolymer-containing X-N plate in 1974. The U.S. Patent 3,905,815 issued to 3M in 1975, discloses a sheet material comprising a base sheet bearing a thin coating of diazo resin over which is a

photopolymerizable layer based on acrylates and methacrylates. 3M also developed a concept of waterless plate (driography) that was patented in U.S. Patent 3,511,178 issued in 1970. This was further modified by Toray which introduced a positive-acting waterless plate in 1977 and negative-acting plate in 1980.

Gravure and Intaglio Plates

Gravure has found limited use of photopolymer plates. The main difference between the gravure plate and a relief plate is that the image on the gravure plate is below the plate surface rather than being above the surface as with a relief plate. So same photopolymer plate materials can be used for both. Flat photopolymer plates are used for intaglio printing as well as pad printing. For a number of years, BASF Printing Systems (now Flint Group) has promoted its Nylograv photopolymer plates for the gravure market. It has found some use as an intaglio plate for pad printing and security printing. It is now marketed as part of the company's Nyloprint line.

Photopolymers in the form of liquid photoresists have been used to etch rotogravure metal cylinders since 1950s. In 1972, DuPont introduced photopolymer-based dry film transfer resist called Cronavure. It was discontinued in the mid 1980s.

Digital Plates

Digital plates are now available from plate suppliers for use in computer-to-plate digital imagers. They are made without use of a film or a camera but by laser exposure using digital data. High-speed photopolymers have been developed for use in lithographic digital plates. Digital plates for letterpress and flexography are equipped with a black mask layer into which the information is transferred by means of a laser beam.

Mergers and Acquisitions

Significant merger and acquisition activities took place in 1980s and 1990s in the relief plates segment in the US. Leading suppliers of relief plates in the US are now DuPont and MacDermid Inc.

Some major acquisitions and mergers in photopolymer printing plates market are shown in Table 1.

TABLE 1. SOME MAJOR ACQUISITIONS AND MERGERS IN PHOTOPOLYMER PRINTING PLATES MARKET

Year	Acquiring Company	Acquisition	Remarks
1980	Hercules	Phasar liquid photopolymer line	From Goodyear Tire and Rubber
1988	W.R. Grace	Flex-Light line	From Uniroyal
1989	DuPont	Howson-Algraphy	From Vickers
1995	Polyfibron Technologies	Printing Plates business	Spin-off from W.R. Grace
	MacDermid	Printing and Electronics business	from Hercules
	Kodak Polychrome Graphics	Graphic Systems from Eastman Kodak and Polychrome Division from Sun Chemical	A new 50:50 joint venture formed
1996	Agfa	Printing business unit	From Hoechst
	Imation	Data storage and imaging business	Spin-off from 3M
1997	Agfa	Graphic films and offset printing business	From DuPont
	Polyfibron Technologies	Napp Systems	From Lee Enterprises
1999	Polyfibron Technologies	Supratech Systems	From Nippon Paint
	MacDermid	Polyfibron Technologies	
	Chemence	Liquid photopolymer business	From Polyfibron Technologies
	Southern Lithoplate	Lithographic plate business	Imation
2002	Lastra	Western Lithotech	From Mitsubishi Chemical
2005	XSYS Systems	Printing Systems from BASF	Merged with ANI Printing Inks to form a new company
	Flint Group	XSYS Systems	
2006	Eastman Kodak	Kodak Polychrome Graphics	
	Southern Lithoplate	Citiplate	