



Technical Service Memorandum 305

Decorating Methods for K-Resin® SB Copolymer

INTRODUCTION. Many printing and painting techniques can be used to decorate K-Resin® Styrene Butadiene Copolymer (SBC) parts. This Technical Service Memorandum discusses the most commonly used decoration methods and considers such factors as durability, appearance, functionality, decorations and cost.

K-Resin® commercial grades include KR01, KR03, KR05, and KR10. KR01 is used almost exclusively for injection molding. Applications include medical devices, housings, molded boxes with integral hinges, toys, and displays. KR03 is easily processed by injection molding or blow molding. Molded applications include boxes/containers, toys, displays, medical devices, and overcaps. Formed applications include portion packages and blister packaging. KR05 is processed using blow molding or extrusion and thermoforming. Applications include bottles, profiles, displays, and containers. Finally, KR10 is processed by blown or cast film. Applications include medical packaging, produce packaging, skin packaging, twist wrap, labeling film, shrink wrap, barrier film, and tamper evident packaging.

PRINTING & DECORATING. When considering the decoration of K-Resin® styrene-butadiene copolymers, the KR01 grade must be treated different from KR03, KR05, and KR10. KR01 can be successfully decorated by any of the conventional processes using ink systems that are normally used on styrenics. This resin has a wetting tension of

approximately 35-37 dynes, adequate for adhesion of many of the inks used in screen process, dry offset and flexographic printing, as well as label transfer processes. Solvents used in many of the inks may attack the surface of KR01 during drying, thus developing additional adhesion of the ink film. One precaution to observe when decorating K-Resin® copolymer is that the stabilizer system in the resin may lengthen the cure times on inks and paints that cure by oxidation.

Compared to the KR01 grade, KR03, KR05, and KR10 are more difficult to decorate. This is primarily due to the addition of a microcrystalline wax added to the resin during the manufacturing process. (Note: KR03NW and KR05NW are the no wax version for KR03 and KR05) The wax is an antiblock agent that prevents pellets and finished parts from adhering to each other. Thus, many conventional decorating methods should not be used with KR03, KR05, and KR10 copolymers without prior surface treatment to remove the wax. The wax can be removed from the surface by washing with isopropyl or methyl alcohol before decoration.

Film grades like K-Resin® KR05 and KR10, have nonpolar surfaces which do not bond well with inks, thereby preventing adequate wetting of the film by the ink. The key to printing nonpolar films successfully is using treating techniques that alter the film surface, primarily by oxidation. This changes the surface polarity and increases the surface tension, allowing inks to bond to the film surface.

HIGH ENERGY SURFACE TREATMENT.

As an alternate approach, high energy treatments can be used to oxidize the surface, increasing the surface tension to a level adequate for adhesion of many inks, labels and other decorating means.

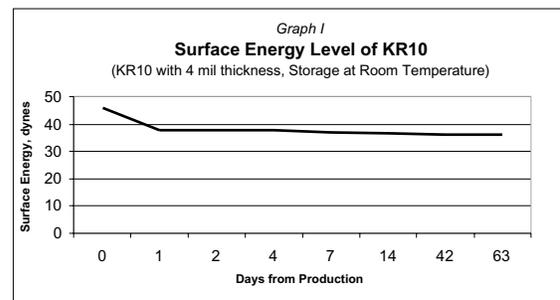
There are several surface treatment methods available such as corona discharge, plasma generation and flame treating. The most widely used method for thick-walled parts is flame treating. However, for films, corona discharge is most widely used.

FLAME TREATING. Treatment by an oxidizing flame for thick-walled parts is accomplished by operating within the parameters of four main variables. The air/gas ratio of the flame is the most critical variable influencing flame treating. The BTU (kJ) output of the burner will balance with the size of burner head and uni-mixer, which in turn will be dictated by part configuration and wall thickness. The optimum distance of part surface from flame tip has been proven to be 3/8 in. (9 mm) to 1/2 in. (13 mm). Lastly, contact time through the flame should be closely controlled to achieve optimum treatment.

CORONA DISCHARGE. The electrical method of surface oxidizing, i.e. corona discharge, has gradually displaced the flame method as the preferred method for films and sheets. This is because their thin gauge makes it difficult to control the extent of the flame treatment. The corona discharge treatment is usually performed in-line with the extrusion process. As the film passes over the roller between the electrodes, it is exposed to a continuous shower of ionized (corona) particles. This treatment allows the formation of ozone, which oxidizes the surface of the film, making it receptive to ink.

As a general rule, the surface tension of the films should be approximately 10 dynes/cm higher than the ink to obtain good bonding of the ink to the film. Alcohol-based inks used in flexographic printing commonly have a level of 20-25 dynes/cm. K-Resin® film, prior to treatment, has a surface tension of <30 dynes. Therefore, to achieve good bonding with the inks, the K-Resin® copolymer film must be treated by a surface oxidizing method. In order to print, decorate, laminate, coat, or even

metallize K-Resin® films, it is essential that they receive sufficient surface treatment. The microcrystalline wax which is used as a pellet antiblock will bloom to the surface and reduce the film surface energy, hence reducing the ability to print, etc. the film. *K-Resin® films will lose approximately 6 - 8 dynes of surface energy over the first 48 hours after production* (see Graph I). So when corona treating K-Resin® films during film production, it is necessary to reach a surface energy level of at least 48 dynes in order to get enough life out of the treat to allow reasonable time for printing, etc.



While it is mandatory to obtain adequate treatment levels, over-treatment can cause problems with pinholes, brittleness and sealing. The effect of treatment also diminishes with time; thus, the time between pre-treatment and printing should not exceed five weeks for the sheet. If stored longer than five weeks, the film must be treated again before printing. This time frame varies with different processing and treating techniques and storage conditions. Handling and dust pick-up may also damage the treated surface.

SURFACE DECORATION. Paints/Coatings/Inks. Many paints and coatings will bond to K-Resin® copolymers, including acrylic lacquers or enamels, epoxies and polyurethanes. Primers can be used on KR03, KR05, KR10 and KR01, while DuPont acrylic/lacquer types work well on KR01 and untreated KR03, KR05, and KR10. Coatings for untreated KR01 are widely available; however, KR03, KR05, and KR10 need surface treatment prior to coating. Selection of a coating among so many options ultimately depends on end-use performance criteria such as durability,

flexibility, etc. Furthermore, certain coatings can impart greater UV and scuff resistance. Of course, paints can also match the color of component parts, especially when limited production precludes cost-effective pigmentation of resins.

Inks received from various suppliers have been tested for use with K-Resin® copolymer film and sheet. Corona discharge was used to treat the film and sheet to a level of approximately 45 dynes. The converter may either make his own ink-solvent formulations, or work with ink suppliers' recommendations. The combination of proper processing and handling, surface pretreatment and ink-solvent formulations are particularly important for printing K-Resin® copolymer film and sheet.

IN-MOLD DECORATION. In-Mold decoration is achieved by incorporating the design directly in the mold or mold inserts. Logotypes and graphics can be either raised above or recessed below the mold surface by machining or engraving techniques. The principal advantages of this technique are the permanence of the decoration and economy. The decoration can also be highlighted to intensify contrast by inking the crests or recesses of the design with fill and wipe inks, dry offset printing or spray masking. Such decoration is ideally suited to K-Resin® copolymer and dramatically enhances aesthetic appeal.

EMBOSSING. Though adapted to sheet extrusion, embossing is essentially the same as in-mold decoration and the same comments apply. One or both of the nip rolls on the sheet line are etched to give the desired pattern. During extrusion, the design is pressed into the molten sheet which retains the impression upon cooling. During subsequent thermoforming, the sheet will still retain the embossed design but with some distortion depending on the geometry of the part.

FLEXOGRAPHIC PRINTING. Though adaptable to other substrates, this method is used primarily to decorate film less than 10 mils (250 mm) thick. The film should be corona treated to a level of 45 dynes or higher, prior to printing, in order to obtain adhesion of

the flexographic inks. Both solvent and water-based inks have been used successfully with K-Resin® copolymer film. Most printing inks do not have numerical values that rate gloss levels; however, surface printing inks usually have a medium to high gloss, compared to laminating inks which are not glossy. Generally, the thicker the ink, the higher the gloss.

Rotogravure printing is also used to decorate film. This process is usually slower than flexographic but provides high quality, detailed printing.

DRY OFFSET PRINTING. Parts must be supported to withstand transfer pressure so their shapes are limited to round or flat. Round parts must have an opening the same diameter as the maximum outer diameter to permit insertion of a metal mandrel. Tapered parts, such as bowls, can be printed when held on mandrels by a vacuum. For printing flat areas, the conveyor positions the parts accurately and moves them under a series of rotating transfer stations.

PAD PRINTING. This concept in decoration is ideally suited for items made of K-Resin® copolymers because the inks are conventional screen process inks. In this process, a soft silicone rubber cone picks up an image from an etched metal plate. A doctor blade controls the ink film thickness and removes excess ink from the etching just before the silicone rubber cone contacts it. Pad-Print can transfer very fine detail, even lines narrower than 0.005 in (0.127 mm).

Possibly the most unique feature of Pad-Printing is its capability of half-tone reproduction using four heads on the same machine. Since the silicone cone repels ink, it will not pick up wet ink from the part, and all four colors can be transferred before drying the parts. The contact pressure is light enough and the cone soft enough to eliminate smearing the wet inks already transferred.

One possible limitation to this process is the inability to print large flat, unsupported surfaces such as blow molded bottles. If air inflation is used to support the walls of the bottle, any irregular wall thickness tends to deform in an irreproducible manner.

SCREEN PROCESS PRINTING. Screen process printing employs a metal wire or nylon mesh fabric pre-stretched on a wood or metal frame. Portions of the mesh are sealed to form a stencil prepared photographically from a black-on-transparent silk screen positive. To print, a squeegee forces ink through the mesh exposed by the apertures of the stencil and onto the substrate surface. Many sizes and shapes of parts can normally be screen printed.

This method offers many advantages in the decoration of containers manufactured from K-Resin[®] copolymers, including high quality reproductions and a wide range of rich opaque colors. Special inks are available that furnish excellent adhesion, weatherability and appearance. The viscous ink film deposit encircles the decoration with a thickness unattainable by any other technique. Moreover, the opacity of the ink permits coverage of troublesome solid areas. Very fine details can still be achieved, however. Since, printing only requires minimal pressure, the process is ideal for thin walled parts, especially when part geometry is maintained by an internal air support system.

HEAT TRANSFER DECORATING. Heat transfer is one of the dominant decorating methods. Basically, the various systems employ multicolored designs preprinted on a release-coated carrier (paper or plastic film) and later transferred to the parts utilizing heat, pressure or both. The principal advantage of heat transfer is its relatively low cost for multicolor designs. High speed printing processes deposit the decoration on the carrier quite economically and all colors are later transferred to the carrier quite economically and all colors are later transferred to the container simultaneously by any of the several transfer mechanisms.

HOT STAMPING. Hot stamping methods are all well suited for KR01, KR03, and KR05. In this system, a heated die presses against a specially prepared foil to transfer dry pigment or metallic film onto the surface of the part. The design is etched or machined into the foil as a mirror image of itself. The foil is then placed between the part and the heated die, forcing it momentarily against the part. Hot stamp foils consist of a polyester, cellophane or

acetate film carrier to which a release coating is applied. Over that, a topcoat provides abrasion resistance and then the pigment layer is deposited by rotogravure. Finally, the laminate is coated with a sizing to promote adhesion to the substrate. Foils compatible with K-Resin[®] copolymers will also decorate polypropylene, polyethylene, and polystyrene.

Hot stamping and hot stamp applied transfer labels are two methods of decoration most compatible with KR03 and KR05. In these methods the heat will cause the wax film to melt, allowing the decoration to contact the surface and adhere. Die temperatures in the 300°F (149°C) range with short dwell times and moderate pressure are recommended. Hot stamp foils designed for polypropylene are equally suitable.

Hot stamping does offer many unique advantages. Other than vacuum metallizing, it is the only technique, which produces true metallic colors on K-Resin[®] copolymers, including a full range of golds, silvers, coppers, etc. For that matter, foils are available to simulate woodgrain, leather, mosaic and many other special effects.

LABELS. There are three types of label systems under this general group. While they are similar in many respects, each has its own advantages and limitations and warrant separate comments.

Pressure Sensitive Labels – In this method, the appropriate label stock is coated with a pressure-sensitive adhesive and overlaid with release paper. (Note: Pressure-sensitive adhesives are a distinct group of adhesive tapes that in dry state are permanently tacky at room temperature and adhere to a variety of substrates; they do not require activation by water, heat, or solvents.) Any conventional printing process, such as rotogravure, flexography, or letterpress then prints the labels. Gold or silver hot stamping can be used for added appeal. Since the choice of preprinting process is so broad, any type of decoration from full half-tone reproduction to economical single-color can be specified. After printing, the labels are die cut to shape and the scrap removed from the release paper carrier.

Pressure sensitive labeling has several advantages. Some adhesive systems exist that

eliminate the necessity of part pretreatment. Soon after initial contact, the bond strength of most adhesives improves so much that the label cannot be removed. However, adhesive systems are available to allow easy removal of the label at any time.

Glue Applied Labels – Unlike pre-coated pressure sensitive labels, glue-applied labels are coated with adhesive just prior to application. The adhesives used cover a very broad range from dextrin gums to polyurethanes and hot melts. The label stock is normally paper but other materials can be selected. The labels are preprinted by any of the conventional printing processes and usually furnished in precut blanks ready to apply to the part.

The conventional adhesive systems require pretreatment of K-Resin® copolymer surfaces (flame treating or corona discharge). With proper pretreatment, however, the bond can be so strong that the label will delaminate rather than peel off the part.

Hot Seal Labels – In this system, the label stock is pre-coated with an adhesive activated by heat just prior to application. The adhesive is determined by the intended substrate use and may require pretreatment. Label stock is normally high quality paper but can be a foil or other material capable of withstanding the heat of activation.

Shrink Labels – In this method, the pre-printed sleeve or tamper evident band label shrinks to the contour of a part. Instead of placing ink directly onto container, the use of shrink labels allow ink to be processed onto flat film. As a result, labels can have 360 degrees of decoration for maximum print area. Because of high gloss appearance, shrink labels can supply eye catching shelf impact. A "no label" look can be achieved while combining clear and printed graphics. In addition, rotogravure printing can occur for up to 9 colors on both line and photo processes. Labels can be used in flexographic or offset processes if required pre-treatment and printing conditions are applied. Additional characteristics include

scuff and scratch resistance due to reverse printing, glass retention capabilities, protective film features with UV inhibitors, and effective anti-blocking from surface moisture and oils.

VACUUM METALLIZING AND

SPUTTERING. In these closely related techniques, vaporized metal atoms or ions are deposited on the substrate surface to form a cohesive metallic coating. The metallic coatings can impart functional properties such as optical reflectivity, electrical conductivity, or electromagnetic shielding. The two processes differ mainly in the method of vapor generation. Vacuum metallizing (also known as vacuum coating and vacuum deposition) refers to methods that use thermal energy to heat the metal above the boiling point and vaporize it. In sputtering techniques, metal atoms are propelled from their source by collisions with high-energy ions generated between an anode and a cathode. The vaporized atoms will condense on the substrate forming the deposit. These are general descriptions and numerous variations of each method exist.

KR01, KR03, KR05, and KR10 can be metallized using either system. Special attention should be given to temperature in both sputtering and vapor depositions. Normally, KR03, KR05, and KR10 parts require some form of a surface treatment for good adhesion.

SUMMARY. All of the described decorating methods are usable with K-Resin® copolymers. Each has certain capabilities and benefits that can be effectively utilized to achieve the desired effect.

This is not a complete list of the methods available, but instead represents a cross-section of the most popular. Many of these methods are modified for specific applications. No doubt new and better decorating methods will continue to develop, complementing the growth of K-Resin® SB copolymers in the marketplace.



Commercial Suppliers of Decorating Equipment

PRINTING INKS

Domestic Suppliers

Kohl and Madden
Division of Sun Chemical Corp.
222 Bridge Plaza South
Fort Lee, New Jersey 07204
Northlake, IL 60164
Telephone: (201) 886-1203
Website: www.kohlmadden.com

Coates Inks, Inc.
1511 S. Batesville Rd.
Greer, SC 29650
Telephone: (864) 288-4931
Website: www.coates.com

International Suppliers

Sun Chemical International
Cow Lane Watford
Herts WD2 6PL
England
Telephone: (44) 1923 661966
Website: www.sunchemical.com

INX Intl. Ink Co.
2647 S. 96th Street
Edwardsville, KS 66111
Telephone: (800) 631-7956
Website: www.inxink.com

Siegwerk, Inc.
4225 Murray Place, P.O. Box 10064
Lynchburg, VA 24506
Telephone: (804) 847-9033
Website: under construction

The INX Group (UK) Ltd.,
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Telephone: 011-44-1 706-868 788
Website: www.inxink.com

ADHESIVES

H. B. Fuller Company
3450 Labore Rd.
Vadnais Heights, MN 55110-5148
Telephone: (651) 236-3155
Website: www.hbfuller.com

Rohm & Hauss
(previously Morton International)
100 North Riverside Plaza
Chicago, IL 60606-1598
Telephone: (312) 807-3449
Website: www.rohmhaas.com

Liofol Company
203 Mackenan Dr
Cary, NC 27511-6498
Telephone: (919) 319-1933
Website: www.liofol.com

Pierce and Stevens Corporation
710 Ohio Street
P.O. Box 1092
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LABELS

Avery Dennison
8612 Main St
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FOILS

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