Denise Breard
205 Ash Lane
Lafayette Hill, PA 19444 USA
Tel: +1 610-397-1928
Email: dbreard@sgia.org or dbreard@aol.com
Website: www.denisebreard.com

Hanging On Through Thick and Thin: *A Look at Static-Cling Vinyls*

By Denise Breard

Static-cling vinyl is a popular substrate for graphic displays, but it's also known to bring a challenge or two to the printing process. Researching common problems and solutions to printing on static-cling vinyl for this article offered me a chance to do an in-depth exploration into both the manufacturing and printing sides of the business, so I leapt at the opportunity.

My recent visit to a static-cling-vinyl producer made me pay greater attention to the wide use of cling decals in our daily lives. We may not often think about static-cling vinyl, but most car owners in the US have at least one example in their vehicles. The most obvious is the decal that reminds the driver to get an oil change. The local auto mechanic sticks it on a window surface in hopes of gaining some repeat business. The American flag is another common cling decal found on vehicles, especially in the post-9/11 era. In fact, these ubiquitous flag decals have helped to keep some screen printers and plastic-film converters profitable in tough economic times. Let's take a look at some other applications for which static-cling vinyl is suited. Then, we'll discuss its chemistry, manufacture, printing considerations, and troubleshooting techniques.

Applications for cling films

Popular uses for static-cling vinyl include window and glass-door displays in fast-food restaurants; seasonal, decorative window appliqués; temporary, protective, non-adhesive masking; removable decals; vehicle-window graphics; and retail refrigerator/cooler displays. Static-cling vinyl's lack of adhesive allows easy repositioning and removal of printed graphics. Unlike large-format pressure-sensitive decals, static-cling products can be applied with relative ease by untrained staff in retail outlets. The material performs best on clean, dry glass, but if the material becomes soiled, it can be cleaned by simple washing and then reused.

Contrary to what its name might suggest, static-cling vinyl does not actually cling to the application surface with static electricity. It clings to smooth surfaces, such as glass, because of the cohesive forces between the smooth surfaces. The soft, highly polished, pliable vinyl is so smooth that it acts like a flat suction cup. This also enables static-cling vinyl to adhere to smooth surfaces in a wide range of humidity levels. One might see the same effect when stacking several sheets of glass on top of each other, or when printing a smooth, capillary film stencil onto a smooth surface, such as acrylic, polycarbonate, glass, or even static-cling vinyl.

Components of static-cling film

A kitchen sponge provides a good analogy for the composition of cling vinyl with its plasticizers. A dried sponge is hard, but it softens and swells when tossed into water. The water makes the sponge soft and flexible. In a similar vein, plasticizers are dispersed throughout the cling vinyl but are not really part of the vinyl in the same way that a wet kitchen sponge has water in it, but the water is not actually part of the sponge. This characteristic comes into play again when we come to the topic of plasticizer migration. Water is free to leave the sponge when driven off by heat or evaporation, leaving behind a hard, inflexible shell. Plasticizers are not quite as free to leave a vinyl compound, but the important comparison is that under improper storage conditions, heat can drive plasticizers to the surface of the vinyl, causing ink-adhesion problems during printing.

Although static-cling materials may seem overly simple at first glance, proper formulation and selection of an appropriate vinyl compound are critical to the production of functional static-cling material. Vinyl is a thermoplastic compound that can be melted, re-melted, reformed, and reused over and over again, which makes it an excellent candidate for recycling. Depending upon formulation and additive selection, vinyl can be tailored for a variety of applications and is one of the most versatile plastics ever developed. Organic liquids, called plasticizers, are among the most useful additives. They provide flexibility and pliability to vinyl compounds, even at low temperatures, and they impart excellent mechanical properties, such as impact resistance and abrasion resistance. Stabilizers are also important in any vinyl formulation, because they prevent decomposition during vinyl processing and enhance vinyl's resistance to weathering, UV exposure, and heat.

The overall safety of the vinyl and its components is a serious issue. The vinyls used by domestic static-cling-vinyl producers are typically made in the USA with low-phenol, cadmiumfree formulations that meet all CONEG and EN-71 requirements, and plasticizers are chosen with consideration for regulatory compliance. Certain phthalate plasticizers have become an issue for printers who use plastisol inks, which are related vinyl compounds. Widely used, general-purpose plasticizers, such as DOP/DEHP (di octyl phthalate or di-2-ethyl hexyl phthalate) and DBP (di butyl phthalate) have been largely replaced in recent years by BBP (butyl benzyl phthalate) and DINP (di isononyl phthalate). The replacement plasticizers are generally considered less hazardous because they are less volatile, even though in some cases they may have less plasticizing ability than DOP. Environmental activists have questioned the safety and use of DINP and other phthalates in vinyl products--including toys--but so far, European Union scientific panels have maintained their original conclusions: that there is no concern for any application, including toys. In the US, a panel led by Dr. C. Everett Koop was responsible for reviewing existing literature on the issue, and it concluded that both DINP and DEHP were safe enough to be used in toys and in medical devices. While concerns over phthalates may seem distant to most screen printers, let us keep in mind the ongoing efforts by our own industry's plastisol manufacturers to find alternatives to phthalate plasticizers commonly used in inks for garment printing.

More than half of raw vinyl resin, or PVC, is chlorine, which comes mostly from electrolysis of salt water. (Caustic soda is the other main co-product of this electrolysis.) The chlorine component can form hydrochloric acid upon decomposition or burning of the vinyl, so care is taken by vinyl recyclers to control the process. The chlorine content of PVC is also responsible for vinyl's inherent resistance to fire. Vinyl is self-extinguishing when removed from a source of fire. The rest of what makes vinyl comes from ethylene, which is cracked from hydrocarbon feedstocks, such as petroleum or natural gas. Ethylene and chlorine are combined in a chemical reaction to form ethylene dichloride which, in turn, is converted into a gas called vinyl chloride monomer (VCM). The last step, polymerization, converts the VCM into vinyl polymer--a fine, white powder or resin known as polyvinyl chloride (PVC), or simply vinyl. Once the additives and plasticizers have been thoroughly combined with the PVC resin, the resulting vinyl compound is ready for processing into flexible films through calendering.

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Website: www.denisebreard.com

Calendering

Calendering involves feeding the thermoplastic vinyl compound through a series of rollers that heat and stretch the vinyl into its final width and thickness. The gap between the last pair of heated rollers determines the thickness of the film. Chilling returns the vinyl to lower temperatures so that the final width and thickness are maintained. Vinyl thicknesses of 6 and 8 mils are popular among graphics printers.

Lamination

Lamination is the process of marrying the calendered vinyl compound to a backing paper or liner, and it is responsible for much of the stability and handling characteristics of static-cling films. One might be surprised to learn that lamination of the vinyl to the liner is performed under pressure only, and not under heat at all. In fact, cold lamination is performed in a controlled environment to keep the heat down, as well as to reduce the potential for contaminants to enter the lamination process.

Vinyl chemistry and finishing greatly influence liner selection. The most important characteristics of the liners are smoothness and lay-flat. Some static-cling and low-tack, removable-adhesive liners are coated with silicone release agents, but many are simply processed and coated or polished for smooth finish. Smoothness, or low Rz value, is vital in order to maintain the adhesive, or cohesive, character of the vinyl upon lamination to the liner. Liners are available in various compositions (kraft, clay coated, poly coated) and weights from thinner 60- and 70-pound liners up through 90-pound stay-flat liners. Screen printers commonly print large sheets of static-cling vinyl, and heavier backing papers help to ensure ease of handling along with dimensional stability. Lighter-basis-weight liners are preferred by flexo and offset printers who use roll media, while screen printers often specify 10-point standard liners. Liners are tested for lay-flat characteristics to ensure performance and handling. The liners or backing papers can also be recycled; however, they cannot be recycled together with the cling vinyl.

The laminated vinyl is rolled under surprisingly high tension so, for example, a wide, laminated roll can be easily converted to several narrower rolls. These narrower rolls would be stored on their sides, like poker chips. The material's tension during lamination must be sufficient to prevent telescoping when the vinyl is placed on its side and then lifted. On the other hand, too much tension will cause the vinyl to stretch, which can affect its finish and printability. Key issues associated with excessive stretch are loss of dimensional stability, potential increases in plasticizer migration, and even changes to surface tension or dyne level.

The liner and the vinyl roll rarely finish at the same time during the lamination process, so it is often necessary to splice material in a roll. For many printers, a virtually indestructible splice is preferred, but some printers request thinner splicing tapes to prevent interference with press setup. Splices can also be made during the roll-slitting process.

Vinyl can be converted with equipment designed for slitting, sheeting, and scoring once it's been properly laminated to the backing material. Many high-volume print operations are equipped with guillotine cutters and sheeting equipment, but roll-slitting machines are normally found in converting shops. The finished sheets and rolls of static-cling vinyl are stored in controlled conditions to prolong longevity, and they're shipped in refrigerated trucks during the summer. Excessive heat can be detrimental to the performance of static-cling vinyl.

The vast majority of static-cling vinyl is clear; a small percentage is white. Custom colors can also be made. I've seen rolls of static-cling vinyl in beautiful colors--red, yellow, blue, green, and even black. There is even a specialty cling vinyl that is made with prismatic, holographic-style embossed foil for special effects. One limitation to the wider use of opaque and special colors is that most cling vinyl is used on clear glass so that the printed image can be viewed from both sides. If the cling vinyl is opaque, the view through the glass is blocked as surely as if a regular, opaque substrate were used for the image.

Testing

Several types of tests are conducted during lamination and after finishing operations are complete to ensure product performance. These tests can also be performed on the print floor before printing

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205 Ash Lane
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a large job. The substrate's surface tension is evaluated by checking the dyne level; vinyl with surface tension of less than 32 dynes is rejected. Pull tests are used to monitor the force required to separate the vinyl from its liner. Sheet flatness is tested by placing material across a surface and measuring any edge lift or curl.

A key test, called snap-back, can also be easily performed in-house by printers. A sheet of static-cling vinyl is peeled away from the liner until only a small strip remains in contact, perhaps 1 or 2 cm wide. The vinyl is replaced onto the liner by hand and checked to see if it realigns with the backing liner. If the vinyl does not realign well to the edge of the backing paper, consider that result as a possible indication that the vinyl may have been stretched during lamination. Slight misalignment is not normally a problem for printers, as the sheets are not peeled from the liners until well after the printing process is complete. Extreme misalignment may possibly indicate some more serious issues with dimensional stability. It is important to note that printing and curing can also affect the snap-back qualities of cling vinyl. Most graphics printers are familiar with the edge-curl effects of insufficiently flexible ink films and vinyl shrinkage under heat from the dryer or reactor.

Static-cling vinyl for screen and inkjet printing

Screen-printing inks for highly plasticized vinyl tend to contain some strong solvent blends in order to cut through the potentially oily surface of the substrate. Isophorone and cyclohexanone are among the vinyl ink solvents that we can easily recognize by smell. Vinyl resins provide the backbone and adhesion characteristics of the inks for vinyl, and some can be modified with acrylics as well. UV-curable screen-printing inks for these flexible vinyls will also need monomers that are strong enough to break through any surface plasticizers.

There are no significant differences in the static-cling vinyls made for solvent inkjet printers and those used by screen printers. However, it's a different story for aqueous inkjet printers. An inkjet-receptive coating is necessary for water-based digital inks, both pigmented and dye-based formulations, in order for inks to adhere to the vinyl. These coatings must hold and stabilize the applied ink, prevent it from spreading or feathering, and promote rapid drying. In

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Website: www.denisebreard.com

order to do this, coatings typically contain a variety of components, including acrylic resins, latex, photographic-grade clear gelatins, polyvinyl alcohols, starches, fillers, hydrophilic silica products, pigments, and other additives.

Although a variety of excellent coatings have been developed, a universal coating for all ink systems has not yet appeared on the market. These coatings are tailored to maximize receptivity for each ink system, so the brand and type of equipment must often be specified in order to select a material with the most appropriate coating. As with all inkjet media, the development of a proper color profile is essential to maximize color appearance for each combination of inkjet ink and coated vinyl. Some printers report that the colors look better on white static-cling than on clear vinyl, due to ink density relative to screen-printed graphics.

Various types of testing can also be performed on digitally printed static-cling vinyl. The most important test is a visual assessment of a test print on a range of materials with inkjet-receptive coatings. Performance of different printers will vary on different inkjet-receptive coatings. Other parameters to check may include water resistance, ink density, ink bleeding or feathering, and ink-drying speed. For example, resistance to water and other substances is important in environments where printed graphics may be subjected to children and cleaning.

Static-cling vinyl supplied in rolls is almost always rolled with the vinyl side out. Some inkjet printers have unique feed systems that require special, slotted cores with reverse-rolled media (with the vinyl side in and liner out), but special cores are unusual in the overall picture of static-cling-vinyl production.

Storage conditions and shelf life

Storage conditions dramatically affect the shelf life and printability of static-cling films. The product's shelf life is generally a few months. Heat and moisture will reduce the shelf life by increasing the migration of plasticizers toward the surface of the film. You can extend shelf life by storing static-cling vinyl in good conditions, typically in temperatures of 72 °F (22 °C) or less and 50% relative humidity. For maximum printability, it is best to order fresh film for the job at hand.

If the printer's inventory of static-cling vinyl does not turn over regularly, the printer may wish to consider top-coated films. These coatings help to inhibit plasticizer migration.

Troubleshooting

Troubleshooting printing issues on static-cling vinyl is fairly straightforward. Most ink-adhesion issues are related to plasticizer migration, particularly in the summer. Even properly cured ink can fail crosshatch and tape testing if the ink is printed over an oily layer of plasticizer! You can confirm that plasticizer migration caused your adhesion problem by wiping the substrate with a clean cloth that is moistened with isopropyl alcohol or other solvent that leaves no residue. Print a test patch with the desired ink, dry or cure properly, and then test with crosshatch and tape.

If the printed ink crawls or develops fisheyes, chances are that plasticizers have diffused from the vinyl and collected on the surface of the substrate. A simple surface cleaning will often take care of this issue. Intercoat-adhesion difficulties are often related to overcuring the first colors down, or the addition of too many modifiers, such as silicone flow controls.

If the ink cracks upon bending the vinyl, then the ink is harder or more brittle than the vinyl. This can be an indication of overcuring or a sign that the ink is not quite flexible enough to match the pliability of the soft vinyl. This can also be the cause of ink-film chipping or flaking at the edge when diecutting. Consult the technical-services specialists at your ink manufacturers for special print jobs. For example, if the customer's image on clear static-cling vinyl requires four-color process plus spot colors, a barrier white, and so on, call the ink company and explain the job requirements before starting the job!

Static-cling vinyl presents screen and digital printers with a flexible medium for producing short- and long-term graphic displays. Matching the ink and vinyl to the intended application and then taking the time to test the finished product will enable you to creatively deliver effective, high-quality results each time you go to press.

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Denise Breard
205 Ash Lane
Lafayette Hill, PA 19444 USA
Tel: +1 610-397-1928
Email: dbreard@sgia.org or dbreard@aol.com
Website: www.denisebreard.com

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ASPT Member Biography

Denise Breard

Inducted into the Academy in 2003

Denise Breard is a technical writer, consultant, and technical services provider. She joined the SGIA Technical Services Team in 2003, following her work as Technical Services Manger for Sericol (Hong Kong) Ltd. Prior to her position in China, she worked as the National Key Account manager for Sericol Australia, and as the Training Manager for Sericol at their US Corporate headquarters in Kansas City, Kansas. While in Kansas City, she developed and presented technical training curricula and served as a resource for Sericol's Technical Department. She is a speaker and workshop leader for industry shows and exhibitions, and contributes to industry publications with over 20 articles in print, in addition to her many special purpose articles for specific training programs.

Denise is a former member of the SGIA Board of Directors and has participated on various SGIA committees, including the Education Committee for which she served as chair. She has served on the Board of Advisors for various printing programs and as adjunct faculty for workshops and training programs, including those offered by the SPTF. Denise has often served as a technical judge in printing competitions including SGIA's Golden Image Competition and Imprinted Sportswear Shows. She has received numerous awards and commendations, but she is happiest about the prestigious Key Award, presented in 1999 by SGIA for her educational contributions to the industry, and about the peer recognition that led to her election in 2003 to ASPT.

Prior to joining Sericol, Denise was a technical sales representative, a regional sales manager, and a product manager for Autotype Americas, Inc. Denise is a foster mom, and an amateur naturalist, chef and scuba diver with a particular interest in marine environments. She lives and works near Philadelphia, PA.

Denise Breard (Member, *Academy of Screen Printing Technology*)
Technical Services
Specialty Graphic Imaging Association (SGIA)
Digital Printing & Imaging Association (DPI)
Screen Printing Technical Foundation (SPTF)
10015 Main Street, Fairfax, VA 22031-3489
Tel: ++1 703.385.1335
Fax: ++1 703.359.1366
Email: denise@sgia.org or dbreard@aol.com
Web: http://www.sgia.org