SERICOL
More than ink…Solutions.

Polyolefins, Surface Energy, & Screen Printing

Screen printers do a lot of work with plastics called polyolefins. Polyolefins include such substrates as fluted polypropylene (such as Corflute brand), polyethylene banner (poly banner), polyethylene and polypropylene containers (sports bottles), polypropylene synthetic papers (such as YUPO brand), and even spun-bonded fabric-like polyolefin materials (such as Tyvek brand). Let's take a closer look at the characteristics of polyolefins and some of the inks that can be used for printing on them. We'll also look at surface energy and why it is so important for screen printing on polyolefins.

The good side to the polyolefins is that they are light, strong, tough, waterproof, impervious to many chemicals, and resistant to grease & oil. Polyolefins are relatively inexpensive, and are bendable, die-cuttable, and resistant to a wide range of outdoor weather conditions. Polyolefins also offer much smoother printing surfaces than many other substrates. The Dark Side of the polyolefins is that they can be problematic for the printer due to variations in treatment level, age, and storage conditions; sometimes it seems like even the weather can cause us to scratch our heads!

Polypropylene is a thermoplastic, rigid, hard material, which is commonly used in signage, containers and bottles, crates, and laminating films. For most common printing applications, polypropylene requires Corona Discharge treatment in order to achieve good ink adhesion. Inks for treated polypropylene are available from several manufacturers in solvent based, UV-curable, and water-containing formulations.

"Fluted polyprop" is the most common polypropylene, and Corflute Brand is the most well known brand. There are several manufacturer of these fluted high-impact polypropylene copolymer products. Fluted polyprop resembles corrugated cardboard in that it consists of outside walls separated by ribs, and is sometimes called "fluted poly" or "extruded twinwall plastic". Corrugated plastics can be manufactured from several different materials, including polypropylene, polyethylene, other polyolefins, and blends. Regardless of the type, composition, or manufacturer of the substrate in question, your customers will usually call these products Corflute. The photo from Corex shows printed advertising signage on this type of material.

Polyethylene is found in containers, solvent-resistant plastic pipes and tubing, bags, and in sheets of various thickness grades. High Density Polyethylene (HDPE) is hard enough to be commonly used for plastic milk jugs, detergent bottles, and margarine tubs. The softer Low Density Polyethylene (LDPE) is used for lids from coffee cans and margarine tubs. Rigid polyethylene sheet is often used for hard plastic notebook binders. A softer, much more flexible polyethylene is used as a banner material. "Poly Banner" usually refers to Low Density Polyethylene that has been print-treated on one side. Some brands of co-extruded polyethylene banner material have been print-treated on both sides. Substrate suppliers will usually offer polyethylene in rolls and sheets, and with or without print treatment. Print treatment may be on one or both sides. An example of a polyethylene bottle is shown in the photo from Bottles of Australia.

Polyethylene is light, strong, and exceptionally solvent-resistant. It normally has a "waxy" feel which distinguishes it from polypropylene. Polyethylene sheets will stretch before tearing. Like polypropylene, polyethylene cuts cleanly and floats on water.

Proper print treatment with corona discharge or flame is essential for successful adhesion of most screen inks to most polyolefins. When decorating bottles, screen printers pass them through “Rings of Fire” (like tigers in a circus trick) for flame treatment immediately before printing. Flat sheet polyolefin is pre-treated by the substrate supplier since most of us do not have the equipment necessary for print treatment in house. Corona Discharge is the most common type of treatment for flat polyolefins, and as printers, we rely on high residual surface energy to ensure good ink adhesion.

Proper ink selection is important for printing on polyolefins. Most conventional solvent-based inks for polyolefin rely on *mechanical* bonding of the ink to the substrate. Relatively aggressive solvents and resins provide the “bite” or adhesion to plastics such as Corflute or containers. Two-part catalysed inks (normally epoxy based) also work well on many polyolefins. Single pack bottle inks often contain a premixed catalyst that requires heat for activation; these inks are usually printed and then dried in a conveyer dryer. There are also a few solvent-based inks for untreated polypropylene, but these are mostly used for pens and other speciality printing.

UV curable inks may need an extra boost to improve adhesion to polyolefin. Mechanical bonding may not be enough for proper adhesion, so the polyolefins can be treated to improve their receptivity to ink. Corona Discharge Treatment is quite long-lasting, while Flame Treatment requires that printing be done almost immediately after treatment. These treatments improve the actual *chemical* bonding of the ink to the substrate. The corona treater photo is from Corotec.

Surface energy level is especially important for UV curable inks on polyolefin substrates. The higher the substrate dyne level, the better the ink “wets out” onto the substrate, and the better the ink adhesion.

Surface energy in liquids is called **surface tension**. It results from the level of attraction between molecules in the liquid; liquids like water have high surface tension. Water molecules at the surface are strongly attracted inward and to each other, which creates a tension in the surface, almost like a tight skin across the surface of the water. You may remember the school game in which the kids float a needle and some ground black pepper onto the surface of the water in a sink. The water molecules stick together strongly and keep the needle afloat. When a droplet of dish soap is added to the water, the surface tension of the water is altered, and the needle and pepper sink quickly beneath the surface. Inks have surface tension levels too. Silicones, bubble breakers, and other flow control additives often work by changing the surface tension of ink so that it will wet out more evenly.

Substrate energy levels are related to the strength of surface reactivity. Untreated polypropylene normally has an energy level of around 29 dynes/cm^2, while untreated polyethylene will run a couple of dynes higher. Substrate manufacturers sometimes recommend that the surface energy of the substrate should be at least 10 dynes/cm^2 greater than the surface tension of the ink. If the surface energy of the substrate is higher, the ink will wet out easily. If the surface energy of the ink is higher, it will bead up. While it can be difficult to determine the surface tension of the ink, we can easily check the surface energy level of the substrate by using a Dyne Test Kit. If you are not familiar with these tests, contact your ink supplier for information or a demonstration.

Solvent based inks for polyolefins usually run in the 28 to 30 dyne range of surface tension; they can often adhere to untreated or marginally treated polyolefins. For most UV inks, the surface tension levels are higher, so the substrate dyne level must be higher as well. UV inks usually perform well when the substrate dyne levels are at least 40 dynes/cm^2; with 42 dynes or higher, we are cooking with gas!

Printing problems with polyolefins are often related to **aging** of the substrate. Surface treatment levels decline with age, so it is important to check the dyne levels when we receive the substrates, and then again before printing the job. A batch of Corflute may have a 40-dyne level when it reaches the print shop, but if it sits around for a few months, the dyne level can easily drop down below the level of printability. The “Fading Dyne Elf” is often the culprit when the same skid of Corflute worked fine last year, but the ink does not stick the next time around. Other factors that affect printing with polyolefins include temperature, storage conditions, anti-static additives, slip agents, and even mould release agents. All substrates can exhibit printing problems when **surface contamination** is a factor.

Printers must check polyolefins thoroughly for ink adhesion and performance. Test the Surface Energy level of the material with a Dyne Kit, especially for Polyethylene. Print as many colours as will be required, dry or cure them thoroughly, and perform proper adhesion tests, such as a "cross-hatch and tape" test. The cross-hatch tool photo is from Paul N. Gardner Co. Check for intercoat adhesion as well as adhesion to substrate. Test for offsetting, and check for blocking if the material will be printed on both sides of the sheet. The ink must continue to adhere even after all post-finishing processes have been performed. Record your observations and results, and you will soon have a valuable troubleshooting resource at your disposal.

Taking the time to understand polyolefin substrates and the recommended inks will help us to eliminate many of the problems with polyolefins, and can enable us to maximise the benefits associated with these highly versatile substrates.