# A Decorative and Protective System for Wares

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## Abstract

A new technology called the Sylvan Process has been developed which advances Digital Ink Jet (DIJ) printing into new markets and applications. It is covered by two US Patents and a third US Patent Pending and consists of applying a substrate to products made of glass, ceramic or plastic, making it possible to decorate a great variety of products with graphics using DIJ printing. A further clear protective coating is usually applied over the DIJ decoration, enhancing appearance, creating abrasion and dishwasher resistance.

The Sylvan Process will advance DIJ printing into markets such as glass drinking vessels, wine bottles, perfume bottles, ceramic mugs, DVDs, plastic bottles and writing instruments. The substrate takes several forms; for glass and ceramic vessels, the sides of the vessel are fully coated. For products where durability is less critical, the substrate is applied by DIJ printing. To encapsulate the DIJ printed decoration, on glass and ceramic products, the sides of the vessels are once again clear coated with urethane; plastic products have the decoration DIJ clear coated for abrasion resistance and to enhance the decoration.

Benefits of DIJ printing are enormous. Each graphic color is applied in one second or less. In addition to vastly better graphic capabilities, there are cost reductions in printing preparation and productivity improvements due to elimination of set-up costs. The Sylvan Process will replace an antiquated process presently used on glass and ceramics which is threatened by the FDA.

## A Decorative and Protective System for Wares

A new technology, called the Sylvan Process, has been developed to advance DIJ printing so it can be applied to glass, ceramic, plastic and metal. It is covered by two US Patents and a third Patent Pending. This presentation will discuss in detail the process for decorating glass and ceramics, and briefly its application on plastic.

To illustrate the Sylvan Process a typical application is described of coating and decorating a glass tumbler. First a brief discussion about Silane. It is an organic silicone and is the key to the adhesion of the urethane coating to glass and/or ceramic vessel. Silane has two chemically reactive groups in its molecular structure; one group reacts (or couples) with the glass, the other group reacts with the polyurethane molecules, creating both chemical and physical bonding of the urethane coating to the Silane and glass. (For coating and decorating of metal a different Silane is used.)

The glass tumbler is dipped in the inverted position into a mixture of 5% Silane in distilled water. After dipping the excess mixture drains and is recycled, remaining droplets are blown off with hot air, fully drying the surface of the glass. The tumbler is then dipped, inverted, into a low solids (approximately 20%) polyurethane coating where the predominant solvent is methyl acetate, a volatile solvent, to get speedy evaporation. After removal from the coating tank excess coating drains off and is recycled. The tumbler then moves into the flash area of a tunnel where most of the solvents are evaporated and drawn with air flow to the coating cure area of the tunnel which is heated by flameless catalytic gas fired infrared heaters. Infrared heat is generated by the catalytic oxidation of a mixture consisting of natural gas, oxygen from the air and the solvent gases from the coating. Water, and carbon dioxide and perhaps some of the non oxidized solvents, are exhausted. (It is a unique method of converting the solvents into heat energy and minimizing solvent emissions into the air.) The coating being very thin (.001”-.002”) cures in about 15 seconds, barely warming the tumbler, resulting in a uniform clear coating on the vertical surface as well as on the rim. The coating can be tinted to produce colored glassware. (UV curing of urethane coatings has as yet not been approved by FDA.) The coated tumbler is then fed into the DIJ printer. As the readers are likely well acquainted with the technology, this part of the Sylvan Process does not require discussion except to mention that the graphics are color separated and color matched on the computer.

After DIJ printing and UV curing the tumbler is again dip coated and infrared cured. A drawing of the complete Sylvan Process will be shown at the conference presentation. The line is fully automatic, picking the tumbler from the shipping carton, dipping and printing are each done in 2 second intervals. The line runs at 15ft/minute and output is 1800 decorated tumblers/hour with virtually no labor.

Extensive tests were conducted on coated tumblers, using a commonly used commercial dishwasher, the Hobart AM-14, cycling batches 30 times on 3 occasions with no failures. Coated tumblers have been used extensively in the household with excellent success. Properly formulated

urethanes have excellent durability and tend to reduce chipping of glass and ceramic drinking vessels at the rim.

The exact same process described above is used to coat and decorate ceramic products.

The Sylvan Process offers exceptional savings compared to the present decorating process for glass and ceramic drinking vessels and solves serious problems with lead and cadmium pigments and glazes.

Here is a description of the present, age old, process and the cost savings. Ceramic and glass vessels are screen printed. Graphics artwork requires physical color separations and ink color matching. The separated color images are transferred to clear films which are then used to make a screen for each color. To print the graphics the screens must be set up on each print station, precisely in position so that the imprinted colors register with each other. (To avoid this tedious process the graphics are sometimes printed using the same inks on a clear film to create a decal which is hand applied to the vessel, the film is burned up in the kiln or oven.) The decorated vessel is then run through a 1200 deg.F. oven where the inks are fused to the vessel. A detailed cost study was conducted in a Canadian company using this process and it was determined that the saving, comparing orders done by the two different methods was US$0.30/vessel! (which sells for about US$1.50).

Many inks and ceramic glazes are based on pigments containing lead and cadmium which are believed to cause cancer and birth defects. To minimize these problems many colors have been reformulated, making them less attractive, to a point where there is far less decorated glassware on the market.

DIJ printing offers tremendous productivity benefits, requiring only seconds between order changes, compared to screen printing (or offset printing) where set ups for multicolor graphics can take 15-30 minutes.

Another major benefit is ease of printing multicolor imprints, especially in advertising copy where the cost of multicolors is virtually the same as a single color. Furthermore, advertising in magazines and on TV can be reproduced on glass, ceramic, pens, mousepads, desk calendars, etc. and are the same quality, especially the newer DIJ printheads with 7 or 8 grey scale capabilities, producing 'near photographic' print quality.

The writing instrument industry is another example where DIJ printing can be used beneficially, replacing screen and pad printing of advertising. A study was conducted in a major US company. The average pen order is 250 units, with an average of 1 ½ colors/order. When the above described costs of order preparation for screen printing and order setup are compared with the computerized art preparation and DIJ printing process, the cost savings were US$0.10/pen. Production volume can almost be doubled and 4 or 5 colors can be printed at no added cost with vastly better quality graphics.

I, with the help of a machine builder, made a prototype printer for pen barrels. It was moderately successful, proving that we could print barrels in 1 second. The quality of print was however not up to expectations. It is difficult to determine whether the software or the printheads were the cause, or both. It was however apparent that too much ink was being deposited on the pen barrel. The plan is to replace the binary printheads, using 8 level greyscale printheads where ink drop size can be controlled, with new matching circuit boards.

The same prototype printer will be used to prove out printing on glass tumblers. The 8 greyscale printheads will once again be appropriate to achieve the 'near photographic' quality which will be required to reproduce floral graphics, for example.

Another application, and perhaps the most significant one, of the Sylvan Process is the printing on CDs and DVDs. The printing was proven out by Xaar with a laboratory printing unit, using Xaar's Leopard printheads. A major DVD manufacturer has recently approved the printed samples and a DIJ printer has been designed. It will apply a white background, followed by the CMYK process colors and a clear coat, all applied by DIJ printheads. The clear coat provides scratch resistance and enhances the CMYK colored graphics.

The DVD printer output will be up to 3600 units/hour and has the major benefit of pausing only seconds between orders. Present methods of decorating DVDs are screen printing and digital offset. Both of these present processes have 15-30 minute setup times between orders. The digital offset machine applies the white background color by screen printing. Its speed presently makes it desirable for long runs. The Sylvan DIJ printer is capable of matching the production of the offset machine and at 65% less cost.

A major benefit of the Sylvan Process is absence of labor, mainly computer and supervisor skills are needed. It is therefore competitive with the Far East and will discourage large orders for glass, ceramic and pens from going there.

Three diverse applications, glass and ceramics, pens and DVDs, have been discussed here to illustrate the variations possible with the Sylvan Process. In addition to glass and plastic, printing on metals is also feasible, especially if Silane is used in conjunction with a urethane coating, as already described when coating glass and ceramics.

A white DIJ ink, which became available in the past year or so, is a breakthrough. As the reader probably knows, the transparency of DIJ process colors necessitates a background color. Always using a white background simplifies the color matching and improves the graphic qualities of the DIJ printing. It is particularly desirable on clear glass, crating a solid, opaque background.

Enquiries are welcomed to discuss the applications described and also to explore other opportunities. Sylvan Point designs and sells DIJ printers, the inks, and licenses the Sylvan Process.

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## Biography

**Hank Sawatsky** received his B.A.S. degree in Chemical Engineering from University of Toronto at Toronto in 1952. He gained experience in plastics at Shell, Dow and W.R.Grace. In 1963 he founded a plastic product manufacturing company which he owned for 30 years. It provided the environment to use his development skills, i.e. inventing the slider lid for travel mugs. In 1995 he started Sylvan Point Inc. with the plan to coat glassware making it break resistant. This led to the Sylvan Process of coating and decorating a variety of products.