

Developments in Cationic UV-Cure Inkjet

BY RAY WORK



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This summer I wrote about free-radical UV-curable inks (the most commonly used Ultraviolet ink chemistry) and the promise of cationic UV-curable inks with their functional advantages. At that time there were no major flatbed printers on the market utilizing this newer chemistry.

Since then, Gerber Scientific Products has announced a hybrid flatbed printer

that uses cationic UV inks, the Solara ion. They outlined a series of major advantages this new printer is expected to deliver. They've been running the printer at their facilities for more than a year and anticipate customer installations in early 2008. In this article I hope to explain the advantages and issues that must be addressed for any cationic offering to be successful.

CATIONIC IN THE MARKETPLACE

Printer makers have been looking at cationic inks for years. A few years ago both Zünd (with their UVjet 250 Combi) and later Durst (with an early version of the Rho 350R) experimented with cationic inks, but were never able to get the cationic systems fully functional. Today both Zünd and Durst depend solely on free-radical ink systems.

So why are these experienced inkjet printer companies so attracted to cationic ink? The answer is simple. Cationic inks promise better performance in just about every way: easy, complete cure, better adhesion, more durability, more flexibility, better solvent resistance, lower UV-cure energy requirements, and better weatherability. With all these benefits, why wouldn't everyone want cationic inks?

THE DEVIL IN THE DETAILS

One important characteristic of every inkjet ink is stability. The ink must not change on the shelf or in the printer prior to being jetted. If it does it will cause reliability problems in the system. If the viscosity increases (becomes thicker), the ink won't jet properly and the printing system won't function.

In the case of UV-curable inks, the formation of "gels" (partially cured ink) in the ink will act as a filter in the system, restricting flow of ink and cause the printer to fail. This can be a problem with both free-radical and cationic inks. For that reason, the design of the ink and its age and storage conditions are critical to successful printer operation. This is especially important with cationic inks because, historically, their most desirable advantage has also been the most difficult characteristic to control in order to maintain a reliable printing system.

When free radical inks are exposed to UV light or heat the curing reaction begins. It's quenched by oxygen and stops when the UV light is turned off.

Cationic inks behave like dominos. Make the first domino fall and all the rest follow. When the curing reaction is initiated in cationic inks, the curing continues until it's complete.

This is why most of the properties of cured cationic inks are superior to free radical inks. The cure is complete. Of course, curing on the shelf or in the ink supply system wouldn't be a good thing. This brings up a major challenge for engineers: to produce a cationic system that does not initiate curing until after jetting.

Another issue that has challenged the success of cationic inkjet printing systems is the propensity of cationic inks to absorb



Gerber's new Solara ION printer is designed to use cationic UV inks.

ambient moisture. Unlike free radical UV inks, moisture in cationic inks will prevent the photo initiators from reacting to UV radiation, quenching the reaction.

In addition, cationic inks are sensitive to acids and bases, which may be present in some substrates. These can also quench the polymerization reaction and cause the ink near the substrate not to cure, which may lead to poor adhesion. All said and done, these are not insignificant hurdles.

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GERBER'S CATIONIC INK

Gerber's new system uses inks they developed in close cooperation with an undisclosed ink manufacturer. A table in the Solara ion product brochure shows a performance comparison with traditional free radical UV ink, reflecting the characteristics of both technologies. One area to note is the cure energy requirement.

In free-radical inks, each photo initiator molecule must receive a photon of UV light to cause the cure. Unlike free radical inks, cationic inks only need to have the reaction *initiated* by UV light. It's a chain reaction, so a less-intense level of UV light illumination is required.

Gerber uses a patent-pending "Cold Fire Cure" UV lamp system, with long light tubes on either side of the printhead carriage that run the length of the fully enclosed gantry. They are left on during printing and add very little heat to the process.

This amount of light is sufficient because they only have to trigger the reaction. In addition, Gerber indicates that these UV tubes last a long time and produce no ozone. With no heating of the substrate, no VOCs produced in the curing of the ink and no ozone from the lamps, no special ventilation is required.


Other cationic inks have been shown to generate benzene, which is a carcinogen. Gerber indicates that their chemistry does not generate benzene. In addition, Gerber states that their patent-pending GerberCAT UV-curable cationic inks have been developed by engineers to be much less sensitive than traditional cationic inks to both moisture (operating conditions include 40 – 60 percent relative humidity, non condensing) and the acid/base issue.

So, with the complete cure, better flexibility and excellent adhesion, the output from the Gerber is purported to be ready for use immediately after printing in vehicle wrap applications — unlike solvent inks, which must dry for many hours before laminating — and some traditional free-radical inks, which do not have the flexibility and adhesion for this application. According to Gerber, in addition to heat-sensitive substrates

like vehicle wrap films, the printer can print onto slick, rigid substrates (such as uncoated glass) that have been problematic for UV-curing printers in the past.



CONCLUSION

If the new Solara ion printer, with its revolutionary cationic ink system, does all it's supposed to do in the hands of the customer, it will be a significant advance forward in the technology of UV inkjet printing. Let's all hope the printer can deliver on its promise. Time will tell as they begin installing these printers in shops around the globe. 

Printing speeds for two print modes with the Gerber ion printer.

User-Selectable Print Modes	Speed	Quality
Performance (2-pass, bi-directional)	639 ft ² /hr	---
Production (4-pass, bi-directional)	318 ft ² /hr	159 ft ² /hr
High Quality (8-pass, bi-directional)	159 ft ² /hr	80 ft ² /hr
Ultra-High Quality (8-pass, uni-directional)	80 ft ² /hr	40 ft ² /hr

(Chart courtesy of Gerber)

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