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R·I·T Printing Industry Center

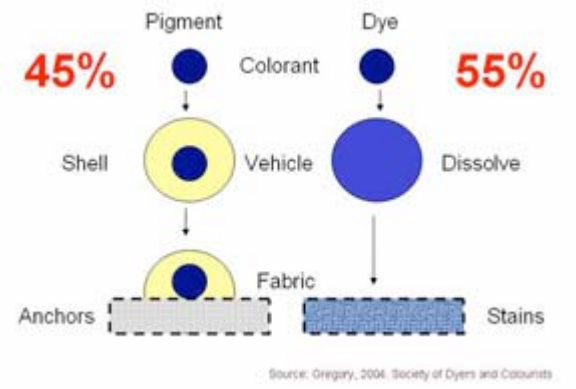
Inkjet Inks for Textile Printing

Decorating fabrics for clothing or shelter has been one of our preoccupations from the very start of human history, and has evolved into today's magnificent textile printing industry. Hundreds of fabrics, dyestuffs (ink recipes for textiles), and printing technologies combine to produce a variety of fine and colorful textiles. Understanding the properties of inks is critical to selecting an ink formulation that will guarantee excellent results. This month's e-newsletter takes a look at the research of RIT School of Print Media graduate student Jorge Uribe on textile inkjet ink formulations.

Basic Ink Properties and Textile Printing Challenges

Printing inks vary widely in chemistry and use. However, all inks are composed of colorants, vehicles, additives, and carrier substances. Colorants are divided into two groups: pigments and dyes. Pigments are colored particles that are insoluble in the ink vehicle and need a binder to attach to the substrate. Dyes are organic compounds that are present in molecular form and soluble in the vehicle. They penetrate the fibers and stain them in the process. Vehicles, also called binders, are usually resins dissolved in mineral oil. Their main functions are to anchor the colorant to the substrate, aid in ink drying, and bring the colorant into printable form either by dissolving dyes or acting as shells around pigments (Kipphan, 2001).

Figure 1: Colorants
click to view larger



Most printing inks used today are pigment-based due to their higher stability, easier handling, and independence of the substrate. However, both inkjet printing and some types of textile printing still widely use dye-based inks. Textile printing by itself brings a range of new challenges to printing, and the variety of fabrics available makes these challenges even more complex. Inks and ink formulations have to adapt to the physical, chemical,

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and technical requirements dictated both by the printing process and the substrate.

Textiles have physical properties not present in paper. Most fabrics stretch and are flexible, and have porous and textured surfaces. Textiles will be exposed to harsh conditions such as washing, exposure to direct light, heavy wear, abrasion, and perhaps drycleaning. Finally, fibers have much greater absorbency than printing papers (Ross, 2001). In brief, the demands on ink and ink formulations for proper results during textile printing and final product use are extensive and intricate.

Dyestuff-Fiber Combinations

The key for proper printing of textiles lies in the proper selection of the dyestuffs according to the fiber content of the fabric being printed. The following table summarizes colorant selections for each textile substrate and the mode of interaction with the fiber.

Colorant	Fiber	Interaction (Bonding)
Reactive dye	Cotton, viscose rayon, silk and wool	Covalent bonding
Acid dye	Silk, wool and polyamide (nylon)	Electrostatic, Hydrogen bonding
Dispersed dye (sublimation)	Polyester	Hydrophobic – Solid state mechanism
Pigment	All fibers	Complex polymer bonding mechanism

Provost, Freche, Hees, Kluge, & Weiser, 2004, p 49.

Demands on Textile Inkjet Inks

Molecular-sized dye-based inks are widely used for textile inkjet printing. They offer bright colors and work well with water for low viscosity and high purity formulations. However dye formulations tend to be unstable, to lack light fastness, and to spread through the fibers, generating poor quality prints (Daplyn & Lin, 2003). Pretreating fabrics with pad liquors and post-steaming or heat fixation are common practices to insure better quality and fastness (Provost et al., 2004).

The alternative is using pigments because they are easier to apply, more stable, and provide overall better color fastness. The problem with this approach is that proper ink formulations of pigment particles in the nano and micro levels have been extremely difficult to achieve. Appropriate pigment formulations require at least 15% of polymer binders in the mix to maintain acceptable fastness (Provost et al., 2004). This proportion of large-molecule binders increases the viscosity of the inks and constantly generates nozzle clogging.

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About the Center

Dedicated to the study of major business environment influences in the printing industry precipitated by new technologies and societal changes, the Printing Industry Center at RIT addresses the concerns of the printing industry through educational outreach and research initiatives.

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Most of the latest research in textile inks has concentrated on improving the formulations of pigmented inkjet inks. Georgia Institute of Technology has tested nanolatex and microlatex compounds as binders with some success for both inkjet and xerography, and they expect better results to come (Tian, 1998). The use of microreactor technology is an alternative that enables precise and controlled synthesis of colorants, generating very small particle size and narrow distribution of high-purity pigments (Macholdt, Geisenberger, Kim, Menzel, & Wille, 2003). One last advance is the use of novel multi-functional polymeric dispersing agents (MFDA) to replace the typical binders. MFDAs provide increased dispersion stability and a permanent attachment to the pigments, generating no agglomerations and controlled viscosity of the inks within the printheads (Provost et al., 2004).

Innovative Products

So-called 'smart' or 'intelligent' clothing is a reality that will impact the textile market. Sensory Perception Technology (SPT^{TM}) adds tiny droplets to fabrics, surrounded by miniature waterproof particles. These particles are washable and cleanable, and are only activated by movement and touch. SPT^{TM} droplets contain amazing things, such as moisturizers, deodorant, fragrance, fresheners, mosquito repellents, and even anti-tobacco agents. Once activated, they are able to soothe, stimulate, protect, or cosset you ("Clothes that love you," 2003).

Clariant Corporation has developed two innovative chemical compounds which add special functions to fabrics. Nuva® is a compound made of fluorocarbon emulsions that, when added to fabric, decreases its surface tension, creating water- and oil-repellent clothing. Rayosan® compounds are special UV absorbers that attach to fabric and improve its protection against sunlight (Weihofen, 2000).

Although the textile printing market is only about 0.1% inkjet in 2004, by the year 2010 the use of inkjet is projected to jump to 10% of the textile market. The future of textile printing and ink formulations will surely be full of challenges and possibilities, limited only by our imaginations.

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Next Month:

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