The Use of Cycolor Technology in Textile Printing

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Abstract

Cycolor Technology combines microencapsulation and photopolymerization into a single layer of photographic coating. This is a dry imaging process; with the imaging chemistry all contained in the coated layer. This paper describes the use of Cycolor technology to digitally print on different substrates especially textiles or fabrics by either of two methods: (1) transferring the image from a 'donor sheet' onto textiles and (2) impregnating the textiles with the active material followed by exposing and developing on the fabric itself. The later technique, because of the nature of the developing process cannot be used with coarse textiles or fabrics.

Introduction

Cycolor Technology , also known as Cylithography[1,2] finds its roots in the carbonless paper technology,[3,4] except that a free radical polymerizable monomer instead of inert solvent is contained in the microcapsules**.**

Cycolor technology offers many advantages for printing:

- No inks, toners or ribbons are required for printing, hence environmentally friendly.
- Panchromatic sensitivity, convenient for exposure by LED, LCD or CRT
- Continuous tone color
- Simple inexpensive and easily developed hardware since the color forming mechanism is contained in the single coated layer.
- High print speed availability for commercial or industrial printers.
- Ability to produce digital images from a compact, portable printer

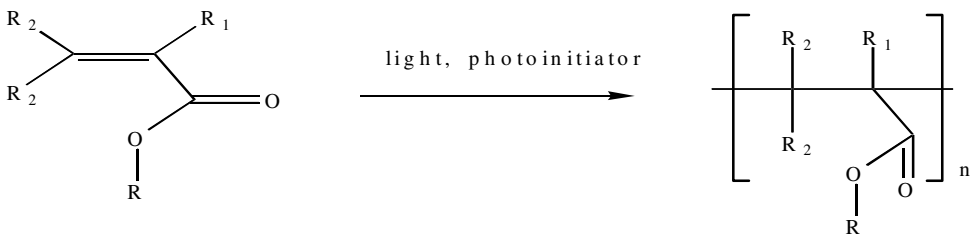
Technology Requirements and Chemistry

Three fundamental processes are required for Cycolor technology application: microencapsulation, coating and photochemistry.

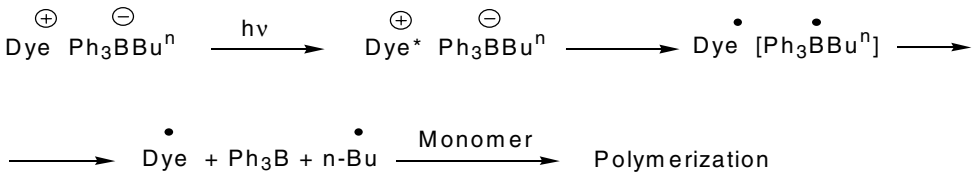
Three basic steps are required to form an image using Cycolor technology namely exposure to light, dye development by applying pressure and heat to accelerate the color forming process.

To produce full color images, atleast three types of microcapsules, CMY are required. Each of these capsules contain both a bleachable photoinitiator sensitive to a different region of visible[5] spectrum and a dye precursor dissolved in a polymerizable monomer. The three types of capsules are made separately and blended together with the developer particles in an appropriate ratio and coated as a single layer on a support.Cyan, magenta and yellow microcapsules are sensitive to red, green and blue lights respectively. All these have the corresponding dye precursors encapsulated there-in.

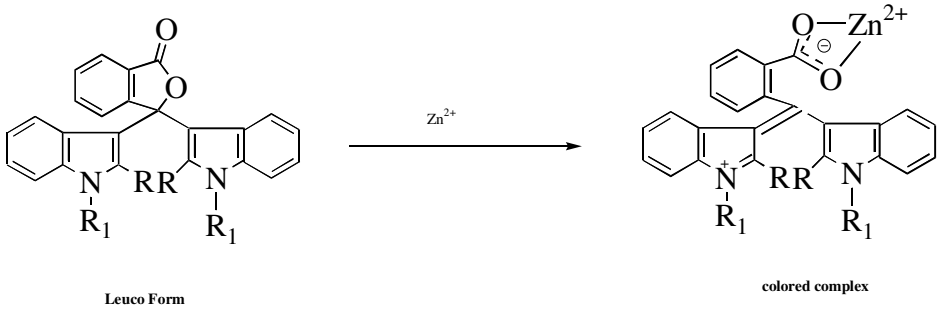
During exposure, photoinitiator absorbs light in the wavelength corresponding to its sensitivity, thus generating a radical, which is responsible for initiation and consequent polymerization of the monomer. This is generally represented in the scheme below:



Scheme 1



Scheme 2.



Scheme 3

Although the detail of the mechanism is not fully understood, a viable scheme has been described by Chatterjee et al[6] and Etter et al.[7] A carbocyanine chromophore absorbs visible light and so attains an excited singlet state. A single electron transfer from the trialkyl borate anion to the excited dye cation readily occurs[8] resulting into a dye and boranyl radical. The latter radical has been independently shown to fragment to the corresponding triaryl borane and an alkyl radical.[9] The alkyl radical is believed to be responsible for the initiation of the acrylate ploymerization, Scheme 2.

Photochemical Reaction

With no exposure, microcapsules remain soft and are easily broken when pressure is applied, permitting the leuco dyes to be squeezed out. The leuco dyes comes in contact with the developer resin and forms a colored complex. Scheme 3. The combination of all three produces black color. In areas fully exposed to light, the photoinitiators are bleached and all capsules are hardened. No liquid is released, hence no dye development occurs and the area becomes white.

In order to get different levels of density; the exposure is varied to form different amounts of polymer within the microcapsules, which controls the amount of dye available when ruptured. Subtractive color mixing is used to create millions of colors, and a continuous tone image. This is illustrated in Figure 1.

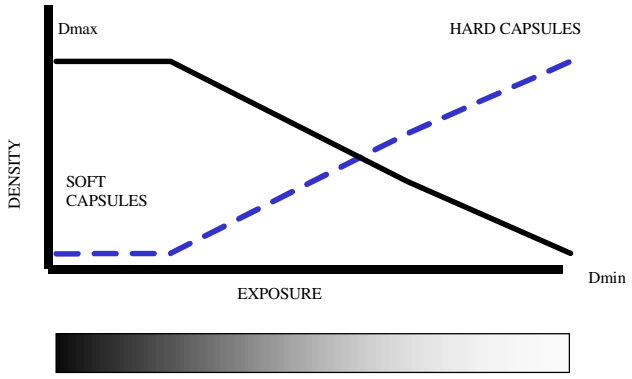


Figure 1. Relationship between color density and exposure

Textile Printing Applications

Cycolor imaging technology can be used for printing on different substrates such as textiles, plastics, metals, glass etc. These wide application capabilities is made possible because of the simplicity involve in the coating of the photographic layer. The photographic layer can be applied using either a composite coating (direct application) or transfer process (Non-direct)

Direct Printing Process (Composite Coating Process)

Using the composite coating approach, a single layer Cycolor emulsion (microcapsules mixed with developer resin) is coated directly on the substrate. Image wise exposure and subsequent dye development by passing the textile web through pressure rollers results in a photographic quality print directly on the textile. The porosity and texture of the fabric is of importance for this process.

Transfer Printing (Non-Direct) Process

The transfer process is a non-direct application of Cycolor imaging emulsion unto the substrate. In this process, the developer resin (receiver) and the photo-sensitive imaging microcapsules (donor) are coated on separate substrates. Two processing techniques can be possible using the transfer method. The donor sheet is separately exposed and the front side of latent image is positioned against a receptor substrate coated with developer resin and the image transferred by application of pressure and / or heat.

These Cycolor imaging processes can be used with T-shirt transfer papers[10,11]

Conclusion

Cycolor technology is very attractive for textile printing. It is a simple and less expensive printing technology that is environmentally friendly. It allows mass customization and minimizes inventory since all the colors needed are present on the single layer coating. Runability issues such as registration, stick-ins, screen stoppage typically associated with most printing techniques are eliminated using Cycolor. Also notable advantage is the design flexibility and the multiple colors achievable from this dry imaging process.

References

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Biography

Dr. Katampe is a Senior Scientist at Cycolor Inc. Since joining Cycolor in 1996, he has focused on developing new applications for Cycolor Technology.

Prior to joining Cycolor, he has conducted research in areas of Dye synthesis, Aziridine Chemistry, Organosilicon Chemistry and multi-step Organic Synthesis.

Dr. Katampe holds a Ph.D in Organic Chemistry from The Open University, Milton Keynes, United Kingdom and a B.Sc from Ahmadu Bello University, Zaria, Nigeria.