A New Check Security Feature: Thermochromic Ink

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One of the newest check security features being utilized today is a logo or mark printed on a check using color-changing ink. This allows anyone to verify the authenticity of a document quickly and easily. By rubbing your finger over the mark, the document can be authenticated immediately, and can be repeated over and over again as the check is passed from person to person. But just how does thermochromic ink work? The chemistry of the ink and use of it both in document security and in other applications are discussed.

Introduction

Many check security features are being utilized today to circumvent check fraud. Some of these features are familiar to forensic document examiners. They include watermarks, microprinting, fluorescent fibers and erasure protection. Other security features incorporate artificial watermarks or pantographs. Chemically sensitive paper is another fraud deterrent product that reacts to alteration chemicals used to remove original check entries. One of the newest protection features is a logo or mark printed on a check using color-changing ink. This allows anyone to verify the authenticity of a document quickly and easily. The color of the logo changes just by rubbing a finger over it or breathing on it. This is either used with a printed message stating that the ink changes colors when heated (Figure 1), or with words that are printed under the color change ink that are visible only when the ink is heated.

This is an excellent check security feature, as a color photocopier cannot reproduce the color-changing properties of the ink. In the event someone attempts to authenticate a check with this printing technology and the colored area does not change colors, it becomes quickly apparent that it is a reproduction. This check authentication process can be repeated over and over again, as often as is needed for verification purposes. When printed, the ink has a shelf life of several years, helping to make this a valuable tool in preventing check fraud.

Discussion

There are several types of color-changing ink. Thermochromic ink changes color when subjected to changes in temperature. Ultraviolet light triggers color changes in photochromic ink. Hydrochromic ink changes color when it comes in contact with water, and piezochromic ink changes color when pressure is applied.

Thermochromic materials were first developed and patented by several Japanese companies in the 1970's. As a successful high-speed printing process had not been developed yet, they were used mainly in the novelty industry. In the mid-1990's, Chromatic Technologies, Inc. developed a way to use thermochromic inks in an offset process. They filed for a patent, and one was issued in early 1997 (Small, 1997). The offset printing process allows high-speed printing with good resolution, which has created the many uses for the ink in document security.

There are two types of thermochromic inks: liquid crystals, and leuco dyes. Liquid crystal inks work very much the same way other liquid crystals work. A temperature change will cause the crystals to change from a liquid crystal phase to a solid phase or to a liquid phase. Due to the nature of liquid crystals they are highly sensitive to minute changes in temperature. Perhaps the

without heat applied

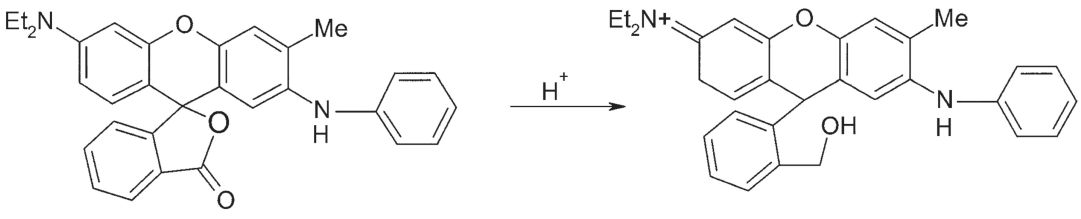
with heat applied

Figure 1. Thermochromic Ink logo printed on back of check.

most famous thermochromic liquid crystal is the mood ring, popular in the 1970's. Thermochromic liquid crystals are still used today in many temperature dependent products, such as aquarium thermometers, stress tests and forehead thermometers.

Leuco dyes are similar in reaction, but their temperature response is not as precise as that of liquid crystals. A leuco dye exhibits color when cool and it becomes colorless when heated. As it takes a 5-10°F temperature change to activate the color change in leuco dyes, they are used in indicators that require less precision than the liquid crystal inks (Homola, 2001). Thermochromic inks aren't just being used in document security. One of the many uses of thermochromic inks today is in the production of labels for food packaging. An example is a label for a beer bottle that has a sports trivia question printed on it. When the label is refrigerated, the answer to the trivia question is visible, yet it's invisible when the label is returned to room temperature. Another example is a syrup bottle label that changes color and displays the message "hot" when the syrup is heated. Thermochromic ink labels are also utilized in the medical field. Labels are designed that are printed with a message that changes color when the labels are autoclaved or heat sterilized. This ensures that they have been exposed to a preset temperature.

How does all this color change work? The process is actually a chemical reaction caused by the transfer of an electron. Figure 2 demonstrates a fluoran leuco dye reaction, from the colorless form (a) to the colored form (b) (Muthyala, 1997). This redox reaction must be protected from the ink chemicals in the ambient solution. The reactants are therefore microencapsulated, using a technology similar to that utilized in carbonless copying or NCR paper. These microcapsules are then combined with regular pigment ink to produce the color change appearance. For example, a microcapsule containing a blue leuco dye combined with a yellow pigment would



a. Colorless

b. Colored

Figure 2. A Fluoran Leuco Dye

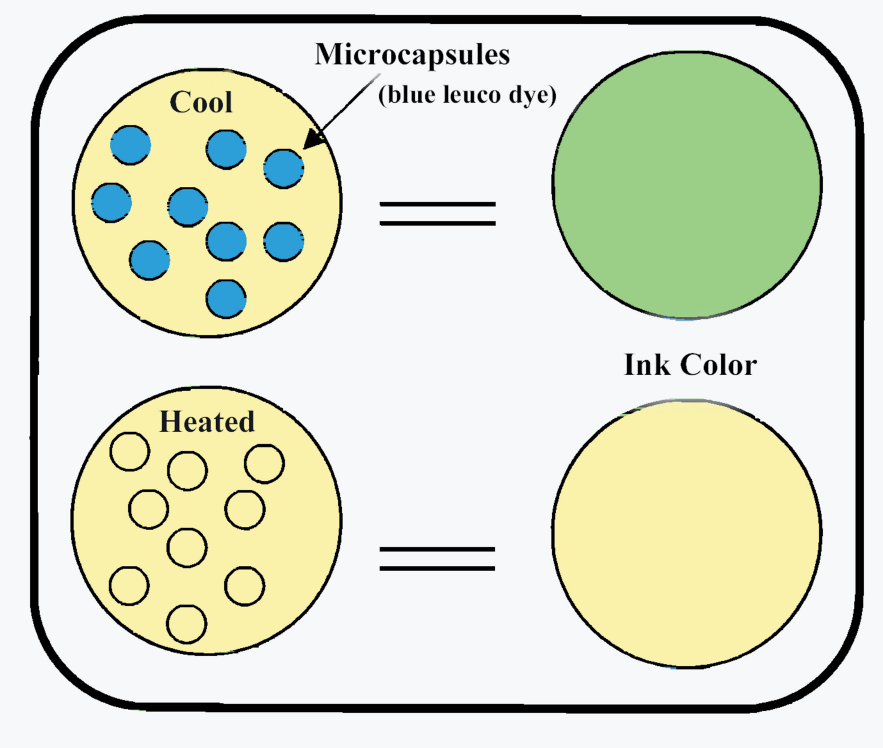


Figure 3. Thermochromic Ink Process

result in green ink. When heated, the leuco dye would become colorless, and the yellow ink would be the only color seen (Figure 3).

This simple chemical reaction makes the printing of many different colors possible. The temperature at which the color changes can also be adjusted. The ink can now be used in screen print, flexographic, or, as previously mentioned, offset processes. It can also be screenprinted on textiles.

Due partially to the security features of the ink, the manufacturers have gone to a great deal of trouble to maintain rigid control of the ink. For example, Chromatic Technologies Inc. has patented both the ink formulation and the printing process. They require all the printers to sign confidentiality agreements for the right to use the offset ink, and they must account for all the ink they use (Small, 1997).

Conclusion

Thermochromic ink printing on documents is a very effective security feature. It provides immediate verification that a document is an original, it can be used over and over again, and it has a printed shelf life of several years. Alone or combined with other technologies, it makes a document irreproducible.

Acknowledgements

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References

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Editor's Note: The article by Lyle Small is no longer located at www.interactivecolors.com. That website has been replaced by www.ctiinks.com/index.htm. Although the article by Small is no longer present, additional information concerning thermochromic inks can be found there. The article by Small can be found at http://theprintdirectory.co.uk/hp/TechnicalTopics/thermochromic.htm.