Methods for Producing Covert Barcodes with Authentication Markers

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Abstract

Barcodes are the once and future king in the area of product identification. Over the past few years barcodes have maintained their place as the first line of defense for product authentication because they pack so much information in such a small area. They are used for everything from track and trace to two part product authentication. Complexity of barcodes and the systems needed to indentify and verify them are continuing to grow. It seems their main limitation is that they are more often than not, visible because most barcodes are validated through optical systems. A visible barcode is one that can be replicated by a counterfeiter. However, the overt, visible nature of barcodes is not likely to change anytime soon as more and more barcodes are being validated by the end user by means of scanned images, submissions of photographs to online databases, apps on mobile phones, or handheld scanners in warehouses.

BrandWatch Technologies has the ability to produce a host of covert barcodes that will make identification and verification of the barcodes more secure than ever. By understanding the limitations of the current state of the art in covert marking detection hardware, a plan was formulated to explore ways of circumventing those limitations by changing the ways the barcodes are printed. By linking the covert markers with the newest developments in ink technology, new and unexpected ways of producing barcodes were discovered. We will outline ways to connect the cutting edge of authentication markers to printing ink technology and identification hardware to produce covert barcode systems while maintaining the integrity of customer facing overt barcodes.

Introduction

Printing of barcodes [1] is motivated by many reasons, from simply following UPC standards on consumer goods, to high level security systems designed for loss mitigation. The value of barcodes lies in their universal acceptance, simplicity, and flexibility. Barcode reading systems are capable of being implemented at all stages of the product life cycle, from cradle to grave. Most products can be printed with barcodes can be printed on any or all levels of packaging and product. Barcodes on outer packaging are used in asset management to assist in tracking the location of products at any time, additionally, this helps prevent product diversion and unauthorized product overrun.

Universal acceptance and familiarity with barcodes does lead to some drawbacks. With global supply chain networks expanding every day, preventing diversion and counterfeit products from watering down the network is difficult, but tracking all barcodes is a way to combat it.

One drawback of barcodes is the very thing that makes them effective, universally accepted carriers of information, they are visible and this visibility means they can be copied. Counterfeiters have the ability to print similar barcodes and in some cases produce higher quality printings than the originals. This is due to widely available printers and software including secondhand equipment that floods the market when printers close or upgrade existing equipment.

Advancement in barcodes including 2D matrices have made it more difficult for counterfeiters to copy barcodes, but not impossible. Simultaneous advancements in mobile phone technology have put the ability to authenticate goods into the hands of the consumers. A quick photograph and access to the internet allow consumers to check that a product contains a unique barcode, verify the authenticity of a product, learn more about that product, and even register a product for warranty claims reasons. On the flip side, the Brand Owner gains such information as how many times a product has been interrogated, where the barcodes are appearing, and capturing information about the consumer during registration. Even if an advanced barcode is trusted to verify the authenticity of goods, what ensures the authenticity of the printed barcode?

We will address methods of producing covert barcode information to either verify the authenticity of a barcode or prevent duplication of barcodes by printing them in a manner not visible by traditional methods. Several covert authentication markers will be examined and the equipment needed to detect and verify the marks have been properly printed. Additionally we will discuss some of the financial impacts of deciding to enhance a barcode system with covert authentication markers.

Methods of Producing Covert Barcodes

Barcodes can often be produced with standard printing technology. Methodologies for producing covert barcodes often overlap with standard barcode printing, but take a slightly different approach. The process of adding covert authentication markers to a barcode on a product begins with deciding what type of information enhancements are desired and ends with the type of detection required to decode the enhancements.

There are many different styles of barcodes and just as many ways to incorporate covert authentication markers into them. The simplest way is to add the covert marker directly to the ink currently used to produce a standard barcode. As long as the covert marker does not alter the appearance and feel of the ink, it would not immediately be known that any change had taken place, putting distance between the producer and the counterfeiter. Several covert authentication markers have the ability to change colors in the presence of the appropriate stimulus, leading to the ability to print barcodes that are invisible to the human eye, unless

stimulated. More complex methods of layering information within barcodes exist, and can be achieved with the appropriate technology partners.

Existing Production Methods, New Inks

A major factor when deciding to add a security system to an existing production line is how much capital will be required for implementation. We propose methods to alter inks used in current printing methods, eliminating the need for capital expenditures on printing equipment. However, in order for this to be feasible, the covert markers placed into inks need to be seamlessly integrated into a variety of inks used by various printing methods.

There are several types of covert markers that can be added to barcodes to aid in authentication of products, but what is the appropriate level of security? Luckily, different tiers of security additives are available in the marketplace and an experienced security provider can aid in recommending a covert marker. Factors to consider when deciding if a covert markers fits into an existing production line include effects on ink appearance, including color and texture, effects on mechanical properties of the printed ink, compatibility with ink solvents and other pigments, and effects on the sheen of the dry ink. Some security ink additives available for printing inks are shown in Figure 1.

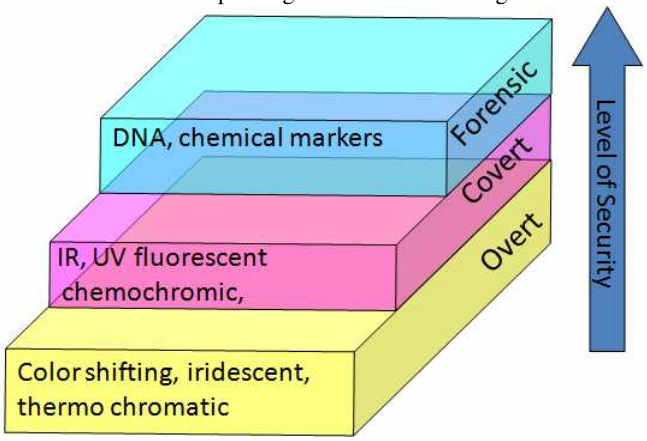

Figure 1*.Diagram of authentication markers and additives that can be applied to printed inks and the level of security they provide.*

In some cases the best way to prevent counterfeit barcodes is to simply change the barcode ink color. Overt security inks include color shifting, iridescent, and thermochromatic, inks that change colors with changes in temperatures. Thermochromatic ink in some cases can be considered a covert security ink type because the color shift may occur at a temperature the barcode is unlikely to be exposed to except during interrogation of authenticity. By the same token, the first level of covert security inks require outside stimulus to appear. Covert security inks include: chemochromatic, inks that change color with exposure to certain chemicals, and fluorescent inks such as infrared (IR) upconverting [2] and ultraviolet (UV). The next level of secure inks include adding DNA [3] and other chemical markers that are more difficult to detect and verify, but also much more difficult if not impossible to counterfeit.

Modifications to Existing Equipment to Aid in Detection

In-line verification or image storage for track and trace of barcodes is already commonplace in many production settings. In addition, handheld barcode readers have progressed to include Bluetooth and Wi-Fi capabilities to make the work force more efficient and mobile. Therefore, modifying existing equipment would be an affordable way to check for authentication markers. The cost savings come from fewer equipment purchases and extend to reducing the amount of training the workforce requires. With only minor tweaks to the system rather than an overhaul, the workforce will need less time to reach proficiency.

Potential modifications to existing equipment dependant on security additive type are outlined in Table 1. The letter in parenthesis preceding each statement of modification indicates either an in-line (I) modification, handheld (H) modification, or possible for both (B). In-line modifications assume observation by either a technician or recorded by a camera.

Table 1: Modifications of existing equipment for detection

Security Ink Additive	Modification
Thermochromatic	(I) Heat or cold chamber to induce color change.
Chemochromatic	(B) Print an extra test pattern and add a drop of activating chemical to induce color change.
UV	(B) Add a UV light source, and (I) filter the camera, or (B) provide filtered glasses to a technician to increase contrast.
IR	(B) Add an IR light source, and (I) filter the camera, or (H) add a handheld IR light source, and (B) provide filtered safety glasses for up close inspection.
Chemical markers	(I) Specialized chemical analyzers could be added to the system, but are unlikely to cause a change detectable by camera. (H) handheld chemical analysis machines could be combined with a barcode reader store or transmit data

Many options are available to enhance current barcode printing lines and the modular nature of many of the options in Table 1 leads to the ability to layer several solutions in a single advanced barcode. Alternatively, handheld detection of many of the covert markers is also available making it possible for inspectors in the field to interrogate barcodes and receive instant verification without having to send product away to an analysis facility while providing real-time feedback to security managers via Wi-Fi.

New Equipment for Detection

Ease of use and affordability lead to modifications of current printing equipment, however, new stand alone detection equipment is often superior. In some cases detection systems cannot be modified to accommodate detection methods because the system is either too large, too costly to add to a printing line, or too complicated to be automated.

New, unique readers designed specifically to detect covert authentication markers are offered by many of the marker producers. If an all-in-one detection/barcode reader is desired, in some cases it may be easier and more affordable to modify an existing piece of covert marker detection equipment and add a barcode reader rather than trying to retrofit a barcode reader with a piece of specialized detection equipment. Chemical markers are one such example because their detection systems are often complex, costly, and have special design features to aid in the most accurate analysis of chemical markers.

DNA verification is a good example of a system that is difficult to automate at the speeds required by industrial print lines. Therefore, DNA is often sent away to a lab that specializes in the amplification of signals from the minute amount of DNA required for verification. However, field agents and production facility workers could be trained to collect samples that could be analyzed by a lab, and in some cases there are chemical tests kits that change colors in the presence of DNA. These kits could not be used to specify the exact DNA strand that was present, but whether or not it was worth sending away to the lab for testing. Other covert markers could achieve the same end result by acting as a DNA carrier. Combining the DNA and other covert marker before printing would allow the other covert marker, e.g. IR markers, for verification that the DNA was present should undergo further testing.

Conclusions

Barcodes have the ability to compactly relay a great deal of information to the producer, inspector, or even the end user of a product. Unique barcodes also can be used to verify the authenticity of a product. The visible nature of barcodes also makes them a prime target for counterfeiting. Criminals simply copy a visible barcode and repeat the pattern over and over on unauthorized products. Authentication of the barcode then, becomes even more important. Several different types of covert authentication markers are available to enhance the security of a barcode and an experienced partner can help guide you through the selection of the product or products that meet your needs.

Stair stepping through different layers of covert authentication technologies allows for greater security of printed barcodes while keeping the counterfeiters from catching up. A major defense in the prevention of barcode copying is the ability to print information that is invisible to the human eye without the proper outside stimulus.

Covert authentication marker manufacturers often also sell equipment design to detect their products. These specialized devices play large roles in both in-line verifications and discreetly allowing inspectors to verify authenticity of products. Perhaps most important to remember when selecting a covert authentication marking system is the interaction with the barcode. The markers should seamlessly integrate into current inks and systems to decrease costs and ramp-up time, while not alerting criminals that anything has changed in the system. With the widespread use of mobile phone camera apps to connect consumers to more product information, it is important to maintain the integrity of customer facing overt barcodes. In the case where the entire barcode is covertly printed it is also important to remember to print a less secure barcode for retailers, and to act as a red herring for counterfeiters.

Future Work

We have only exposed the tip of the iceberg of security barcode printing with covert authentication markers. As long as products are being sold at a profit, counterfeiters will exist. Flexibility in printing with covert authentication markers allows Brand Owners to fight back. Finding technology solution providers that are flexible in their offerings also allows for advancement without delay.

Current and future work focuses on methods to increase security of both the barcode and the detectors used in verification. As the detection systems become more portable they are exposed to more inspections at unsecured locations and must transmit data across potentially unsecured internet channels. Discretion also plays a big part in detection, allowing inspectors can feel safe when interrogating products rather than fearful that their activities may bring unwanted attention from potentially dangerous counterfeiters.

New and different layering techniques are being explored every day as advancements in ink and marker technologies are achieved. Previous solvent-ink interactions and temperature limitations are being overcome by thermal and chemically stable markers in development.

Acknowledgements

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References

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Author Biography

Director of Product Engineering for BrandWatch Technologies. Dr. Eick earned his doctorate in materials engineering from Purdue University. Dr. Eick has led the company's development of unique security taggants and is responsible for the 2009 release of the SecuriTagg product line. In addition to being responsible for the company's line of brand security taggants, Dr. Eick directs research and development of the company's field detection systems.