A whitepaper on:

Invisible and Fluorescing Bar Code Printing and Reading

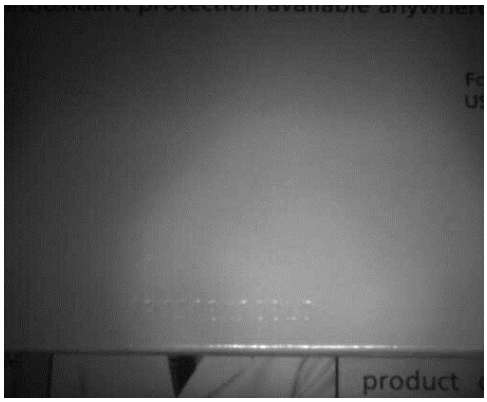
Important technical considerations that are the key to successful implementations

Version 1.03

OVERVIEW

Background:

Inks that are invisible to the human eye have been available for years. Only in recent years has there been an interest in using these fluorescing or “invisible” inks for printing machine readable marks, such as bar codes. Many have said – “this is SO easy to do! ” and it certainly can be. Just using a clear, “invisible” ink that has specific fluorescing properties, with most types of inkjet, thermal transfer or other common printing methods could not be simpler. As more people attempt to use conventional printing concepts to this specialized printing, there are challenges to the success in their efforts, especially if one cannot clearly see and easily inspect the result of their printing.



Normal illumination

UV illumination

InData Systems has over 25 years of bar code involvement and has led the industry in reading covert data marks. This paper provides information to help make your covert data marking project a success. Whether your purpose is to track possible diverted distribution of products, subtly identify a label or an item in transit to an end destination (either within your facility or outside), or provide authentication of an item or document, this paper can help you avoid challenging situations that would compromise your success.

In this document we will be addressing the following to maximize effectiveness in scanning these “invisible” bar codes:

- Bar code Types
- Types of Background and Media
- Background Variations and printing over text
- Types of covert and invisible inks
- Uses and advantages of “Invisible” bar codes

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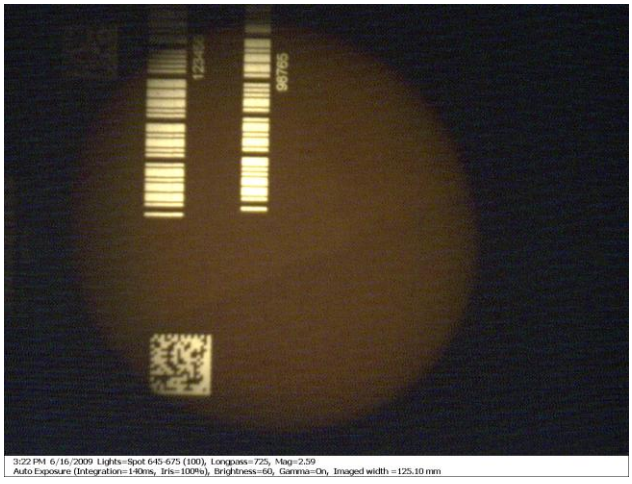
Bar code types:

While linear bar codes, such as UPC and Code 39, have been the predominant form of bar codes for years, 2D bar codes such as Data Matrix and QR code have risen quickly in use. Not only do these codes offer the ability to put more data in a smaller area, but with the inherent aspects of the 2D codes having error correction, they are increasingly being used across many industries and often as low cost alternatives to RFID labels.

Bar code scanners have become widely available that can scan both linear codes and the 2D codes through the use of LED illumination and camera-like imagers, rather than older designs that use just a laser beam and mirror systems to read the printed codes.

Regular, linear codes depend on a bar-space ratio to encode their information, and when the ink used is a fluorescing type of ink, the spacing between bars can virtually disappear as the illumination or the fluorescence increases. Linear bar codes may have check digits and other simple means to identify if the bar code was interpreted correctly, but if there are parts of the bar code that cannot be interpreted due to the over-fluorescing of the ink or excessive illumination, there is no way to overcome the errors to make it readable.



1D, Linear codes frequently can take up 3-4 inches (7-10 cm) in length to get just 8-10 characters encoded. The need to have an even “excitation” lighting for the fluorescing ink becomes difficult over that wide of an area. If one prints the code with very thin bars, as is possible with many of the refined digital printing techniques, the very narrow spaces between the bars can appear to disappear due to the “blooming” effect of fluoresced codes.

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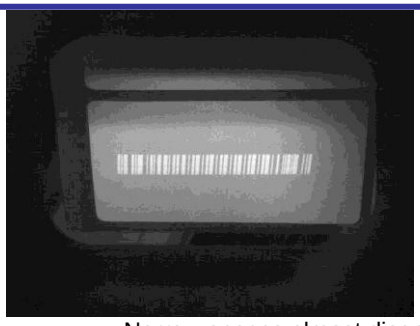
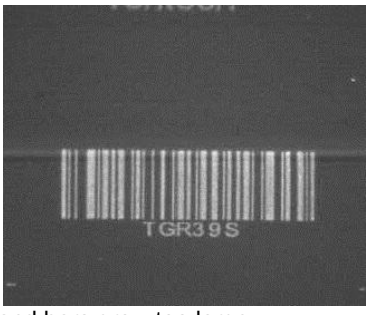
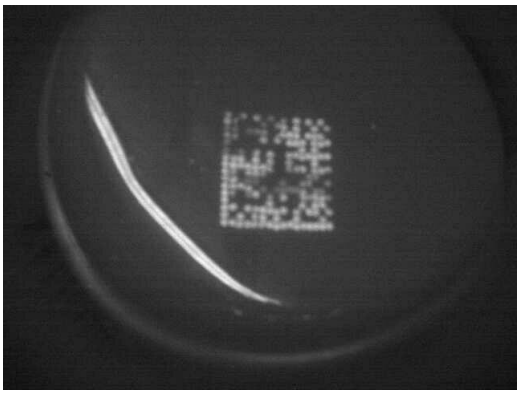




Narrow spaces almost disappear and bars grow too large

2D codes can encode 10-20 characters of data in less than a half of an inch (approximately 1 square centimeter). This smaller area required for the code, both allows the best locating of this fluoresced code for ease of reading and also allows it to be placed on even colored background, which further improves the readability. With the error correction feature of 2D codes, this allows a percentage of the code to be damaged or unevenly fluorescing, and still be readable. With any 2D bar code type – it is always wise to allow at least 2 "pixels" of quiet space around the bar code to assure ease of decoding. Do not allow text or graphics to intrude closer or touch, as this can impede decoding.



2D Bar code still decodable even with faded areas

As the use of "invisible" bar code requires a specialized scanner to read it, even though a printing facility is most familiar with the printing of linear codes, it is well worth considering use of the 2D codes for this covert marking application. Even the end customer who will use these printed codes needs to acquire different scanners capable of reading these "invisible" codes and so they should be receptive to using 2D codes.

Certain applications CAN require a 1D code due to inline machine printing equipment or shallow height available on the item to be marked, but most applications can benefit from the use of 2D codes. A "long and skinny" (rectangular) version of Data Matrix is available to use in smaller areas where there are bar code height restrictions that impact the quality of code.

Rectangular Data Matrix code - alternative format

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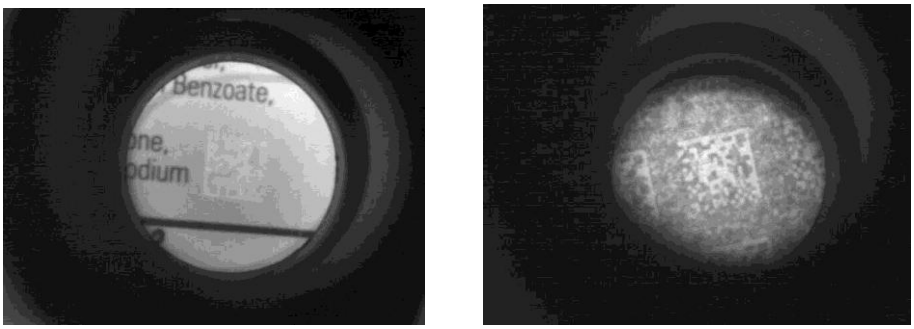
Types of background and Media:

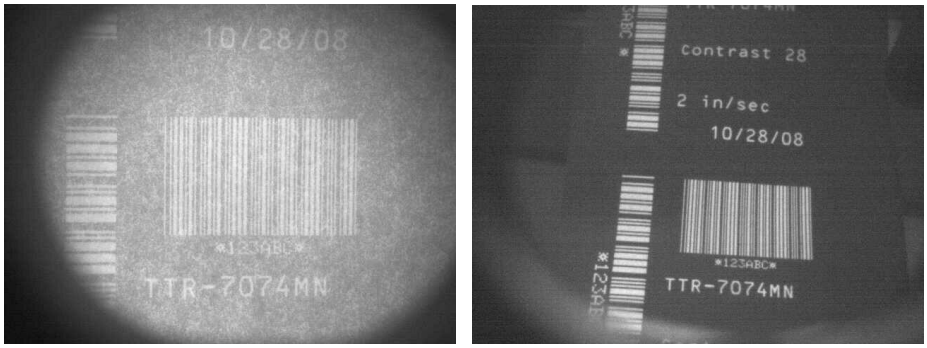
There is a wide assortment of media that may be used for the background material. Fluorescing inks can be printed just as easy as normal colors frequently, but some considerations need to be addressed.

Many white paper stocks and label materials have what is called “optical brighteners” used to make the paper appear very white, in attempts to make a black or color printing on it, have high contrast and visual appeal. If the desired fluorescing ink is a UV (Ultraviolet light) excited ink that glows with a bluish white nature, which is one of the most common variety, this can cause challenges in discerning the fluoresced ink on this paper that happens to also fluoresce, due to these optical brighteners.



Poor contrast due to fluorescing of background paper

If the paper must be of this optically brightened nature, there are solutions available in the market with UV fluorescing inks that glow in the red or yellow-green spectrum. Especially red fluorescing inks can easily be discerned by selecting the correct filtering options in the bar code scanner. InData Systems has developed specific combinations of wavelength of “excitation” and filtering combinations to read these codes easily.



Red fluorescing ink on bright white paper without and with InData Systems enhancing filters

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If the paper can be of a non-optically brightened nature – then the blue-white UV fluorescing inks can easily be read.

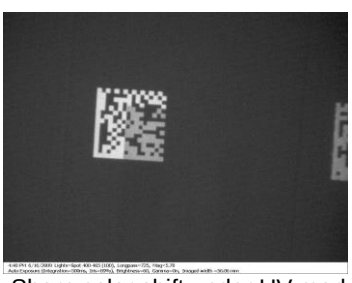
If one is using an ink that fluoresces due to "excitation" by other than UV, such as the less used but more covert, Red->IR, IR->IR, or other proprietary formulations, then this background media issue can be less critical.

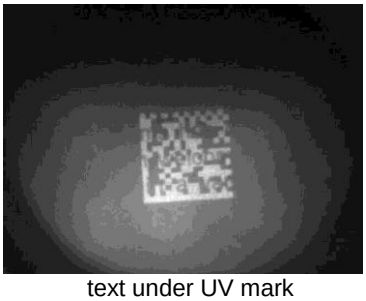
Background variations and printing over text:

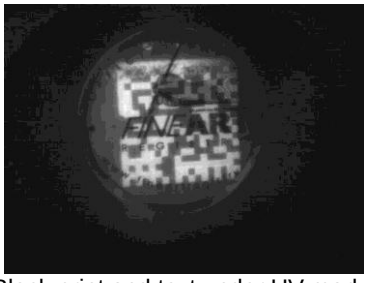
It has frequently been tendered that it would be nice to print the "invisible" code over normal pictures or text on a package. This can be done, but it frequently required significant attention to the inks used in the background markings/coloration and it typically is easier to just locate this fairly small data matrix or other 2D code in a non-printed or evenly colored area.

A select example of successful print behind a readable UV fluorescing bar code

When ink fluoresces due to the excitation by the scanners' LEDs, the ink fluoresces in all directions, both down toward the background media as well as up to the scanner's optics. The issue comes in to play that the background media can reflect the fluoresced light up to the scanner optics as well, but variations in the background, such as text printing or severe color variations in a picture, cause varying amount of light to be reflected. This varying amount of reflected light can cause the perceived corruption of even the most robust, error correcting type of code.


Sharp color shift under UV mark


text under UV mark


Black print and text under UV mark

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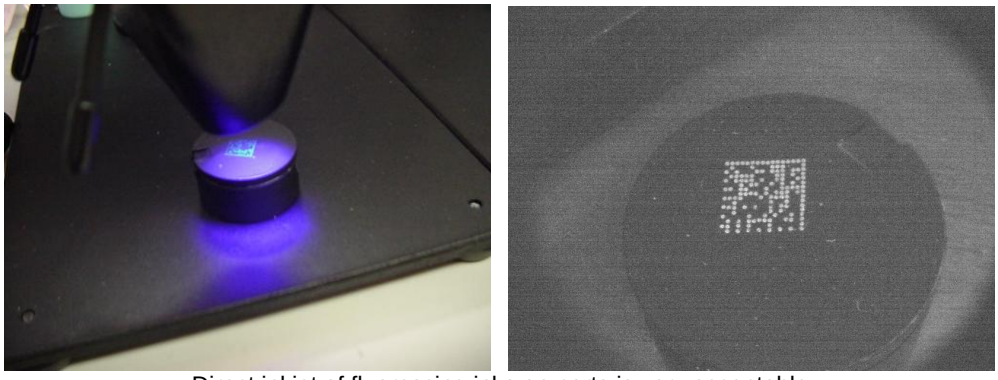
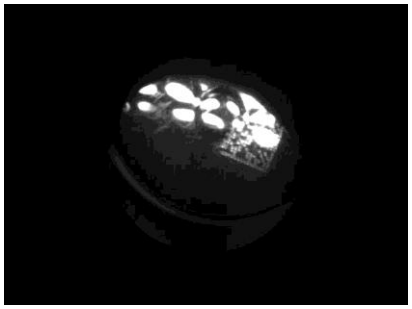
We have found that in the security industry it has been a growing practice to use plasticized or metalized labels that have holographic attributes. In most applications where these holograms are in the media, we are able to read many types of UV fluorescing inks that have been printed on the top surface. This gives the brand owner at least two types of authentication. One of the “overt” viewable hologram and one of the “covert” (invisible to the human eye) bar code. Serialized or batch controlled labeling can be done easily with these covert bar codes printed with fluorescing inks.



Direct inkjet of fluorescing inks on parts is very acceptable

Printing of covert “invisible” bar code marks can be done directly on the object that needs to be identified, thereby not requiring a label. It can be done on recessed areas or domed parts, but deformities in the background material can affect the quality of printing as well as possibly cause specular reflections that can be perceived as defects in the fluoresced code.



Specular reflections cause challenges in reading

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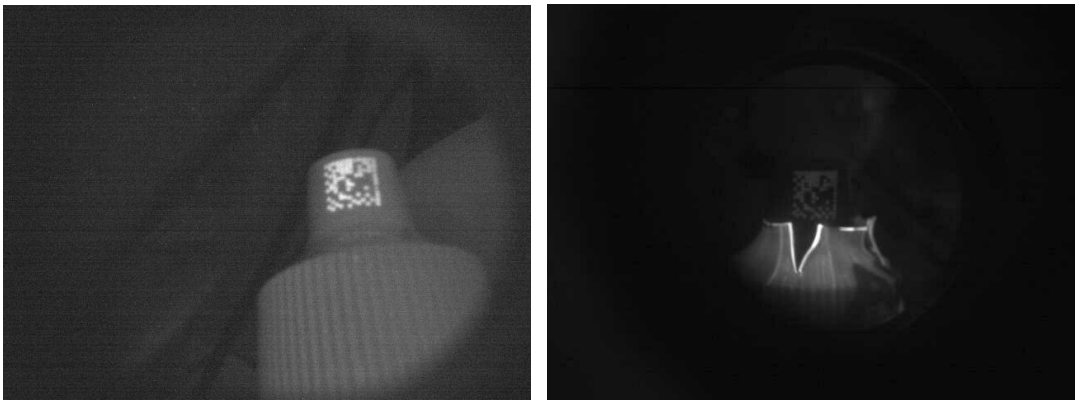
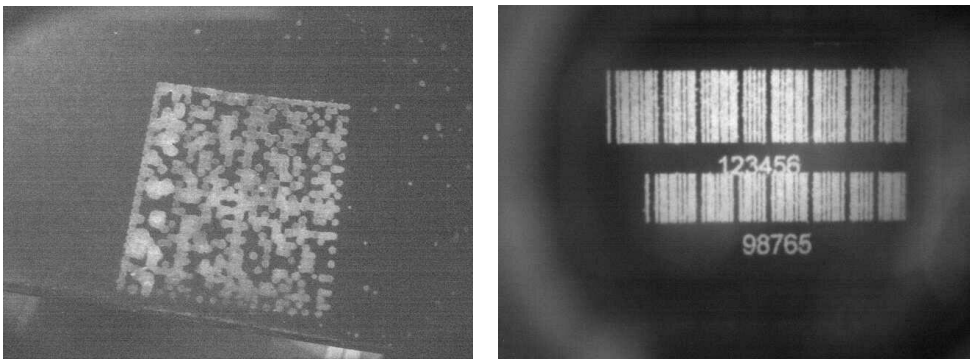
Some plastics fluoresce as well, and having a brightly glowing plastic near the code printed area can cause an automatically adjusting scanner to miss-adjust its gain, just as a camera can take a poor picture of a room if there is bright sunlight coming through a window.



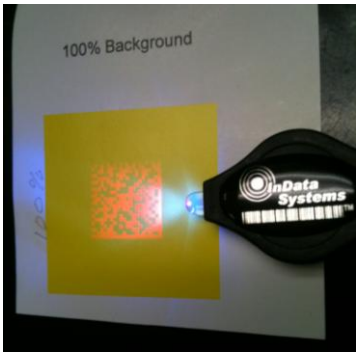
Good readable codes can be compromised by adjacent fluorescing plastics.

A unique issue arises in the printing of these invisible marks directly on materials. When a normal black ink is printed onto an object the operator of the printing system would notice any flaw or printing error, but without the proper tools at the printing and inspection stations, poor quality marks may escape detection:



Blotching and ink spread can go unnoticed without UV illumination tools at inspection.

Simple tools like a UV flashlight (also available from InData Systems as well) can assist in inspection of fluorescing printing:



UV flashlight assists in inspecting quality of “invisible” UV printing

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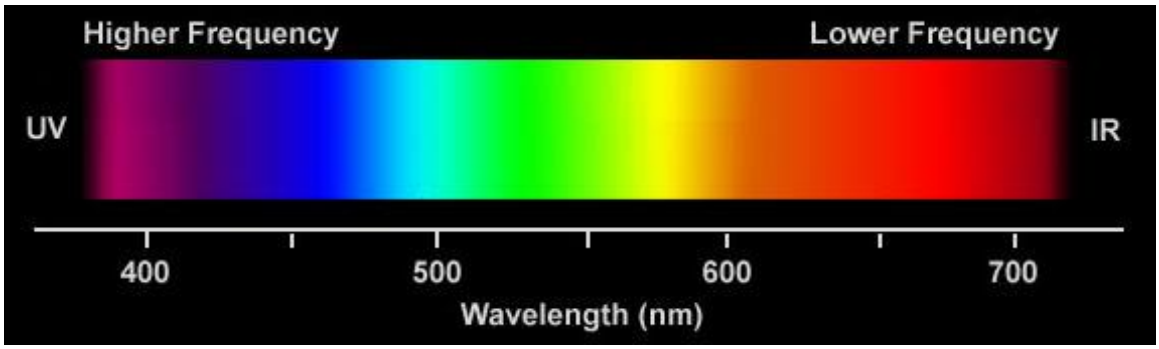
Types of covert, invisible inks:

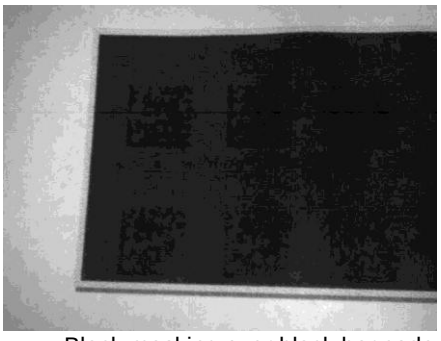
We have spent much of this document using the UV (Ultraviolet light) ink that glows in the bluish white spectrum as our reference, since it is one of the most common inks. It is far from the only covert ink available though. Earlier we mentioned a UV fluorescing ink that when excited by the UV, glows with a red nature that is useful when the paper is optically brightened.



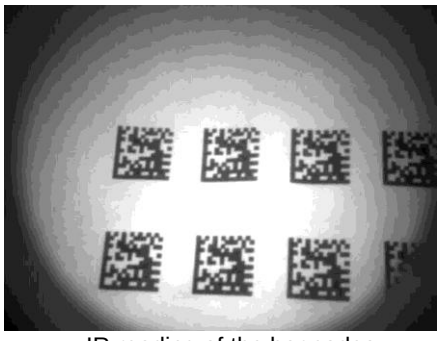
There are inks available from select ink and taggant companies that can fluoresce when exposed to a red illumination light in the scanner (at a very specific wavelength) to cause a fluorescence in the infrared spectrum, that is beyond the human eye's ability to see it. While this ink is ideal in certain applications, in that even a counterfeiter or diversion entity would not be easily able to locate or obliterate this identifying mark, it can have its limitations as well.

Certain brands of these inks are more sensitive to sunlight and bright office illumination, and with prolonged direct exposure to this lighting, the ink can fade some, making it unreadable. If a mark can be put in an area that is not regularly exposed to this bright lighting, i.e. inside a package or on a document that is not left out in the sunlight typically, this type of ink can be quite effective.

It has been a practice in bar code applications, especially bar coded time cards, that a black strip is placed over the bar code to prevent unauthorized copying of the bar code. This has been referred to as a "black on black" printing in which the bar code (1D or 2D) is printed with a carbon based ink and the black (or other masking color) over print is a dye based ink that is optically transparent in the infrared spectrum.



Black masking over black bar code



IR reading of the bar codes

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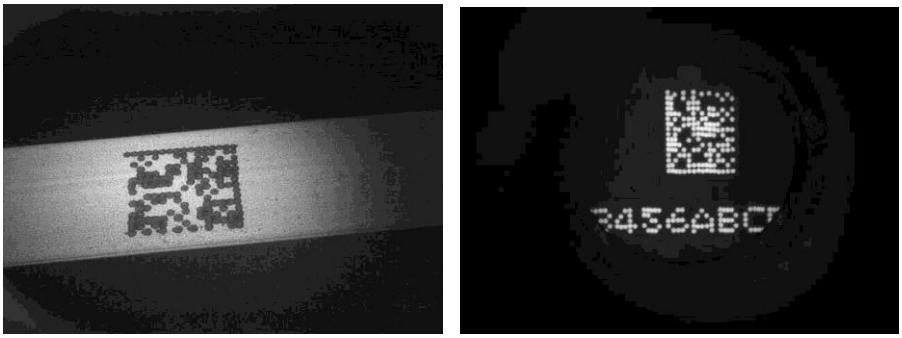
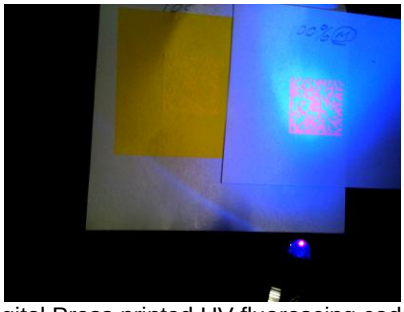
There are several different methods of printing these covert bar code marks. They range from a CIJ (Continuous ink jet) method that is flexible enough to print on irregular or at a varying distance from the edge of the product to TIJ (Thermal Ink Jet) printing which is excellent when close proximity can be maintained as in label or document printing. These “dotted” bar codes can usually be very well controlled, but poor regulation of the speed of the product going by as it is printing can cause the bar code to be improperly formed.



Both of these bar codes should be equally square in height and width

Thermal Transfer Printing using a ribbon as is used in shipping labels can print this invisible (clear) ink onto labels and allows one of the most accurate square crisp printing of fluorescing bar codes.

A newer method of digital printing has come on the market with vendors of high end digital printing equipment offering a fluorescing ink or covert hidden mark printing method allowing the brand owner the highest quality labeling on a package or ticket with highly variable covert hidden information on the item.



Digital Press printed UV fluorescing codes

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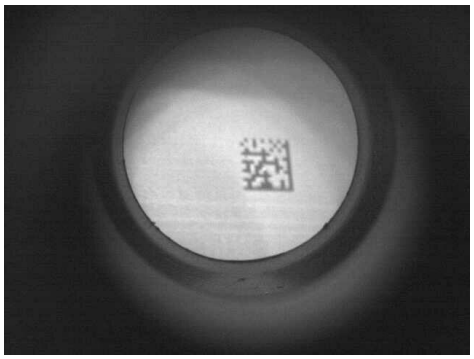
Another interesting method of printing an “invisible” bar code mark is to actually use the optically brightened over-varnish that may be used as the last printing step in a label creation. By having a printing roll instead of just a roller coating, one might have a result of a black on white bar code by just NOT applying the varnish in a select area, in the pattern of a data matrix bar code!

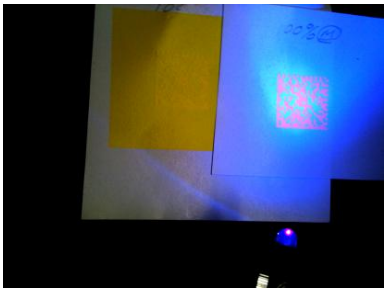


Clear label with selective over print of common optically brightened varnish

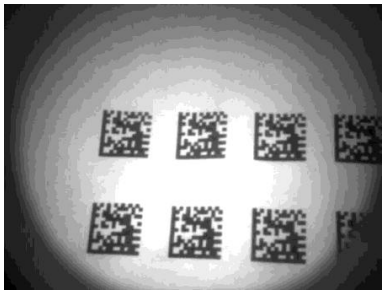
Successful covert “invisible” bar code printing examples:

Dye Sublimation (ID card)

Thermal Transfer (label)



Dry fluorescing ink (Venue ticketing)



Thermal Ink Jet (TIJ) on paper

Continuous Ink Jet (CIJ) direct on products

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Uses and advantages of "invisible" bar codes:

- Unobtrusive marking for label or part identification
- Tracking of restricted items that are highly subject to counterfeiting such as pharmaceuticals
- Covert track and trace of restricted distribution products – wines, cigarettes, promo items
- Authentication of Branded Items
- Warranty tracking of materials used in construction
- Sporting and other Venue ticket authentication

Summary:

As the covert bar code printing technology matures and competition grows in the domestic and international security marketplace, it is vital to the success of anyone embarking on this technology, to be knowledgeable and informed when selecting and combining printing methods, media and covert or fluorescing inks, to facilitate optimum results.

We want to get the message out there that there is competition for this technology and that success will only happen when the proper combination of printing method, media and ink is used. This can greatly be facilitated by knowledge and education. InData Systems has done much of this research through our work with international partners providing samples for our analysis. We have invested the time and effort into this research to enable you to have successful implementations of your covert or security printing application.

InData Systems manufactures the widest range of bar code scanners for fluoresced inks ranging from corded and cordless scanners, mobile (Batch and WiFi) Data Terminals as well as high speed in-line scanners capable of reading fluoresced codes moving at rates over 500 feet per minute (150 meters per minute) which can relate to over 20 reads per second, depending on print size.

Appendix – informational Links:

http://www.uvreaders.com - InData Systems site for covert bar code reading equipment

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