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Overview of security printing types and trends in its future development

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In the current research are described various ways to protect secure documents, lables and packages, and the different security printing techniques applied today and the way they will evolve in future.

Security end products constitute a wide variety of different types of documents, packages, labels and cards. The degree to which these need protection from counterfeiters, forgers and terrorists depends upon how deleterious their illegal procurement and misuse is to human welfare and financial stability.

In order to reduce forgery and counterfeiting, the printing industry uses a big range of variable security methods and via different combinations, a high security document is achieved. Security printing devices are often categorized as overt, covert and machine-readable.

Another advantage that the security printer has today is the ability to produce security documents on nontraditional, nonporous substrates such as plastic and polymer - biaxially oriented polypropylene. Due to this complexity in its chemical structure documents and banknotes have a greater abrasion resistance and lower rate of tampering.

Key words: security printing, substrates, inks, printing technologies

INTRODUCTION

Security printing is the field of the printing industry that deals with the printing of items such as banknotes, cheques, passports, tamper-evident l labels, product authentincation, stock sertificates, postage stamps and identity cards. The main goal of security printing is to prevent forgery, tampering, or counterfeiting.

Different types of printing techniques are suited to different applications. Sometimes a heavier weight of ink is needed on the substrate in order for the security feature to work properly. In other instances is needed to use a technique that uses a more delicate approach, so that the detailing in the artwork adds to the security.

In recent days and in an overgrowing market, the industry of Security printing is struggling to bring up new ideas, with more security features and less coasts. Vital parts in printing industry play the latest approaches in the field of chemistry. The ability to produce security documents on nontraditional, nonporous substrate such as plastic and polymer is not anymore a futuristic technology, but an adequate solution in several spheres. [1]

SUBSTRATES IN SECURITY PRINTING

Substrates for printing are mainly paper, polymer and cardboard. Security substrates can be designed and manufactured with special features and considerations to protect documents from counterfeiting or alteration of information (forgery).

Security fibers. They are embedded in the upper most layers of the security paper. Usually they can vary in colors. There are several different types of threads – natural or synthetic materials, and can obtain different spectral features either fluorescent or non-fluorescent. This feature is often used in banknote printing paper (Fig. 1) [1,4].

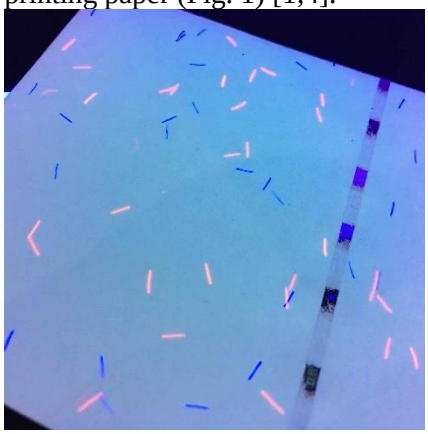

Fig. 1. UV fluorescent threads and hologram thread.

Security thread: or also known as hologram thread is an embossed in the paper dark metallic thread, which can contain a micro-text visible by placing the paper to light (Fig 1).[1,4,5]

Watermark. A watermark is an identifying image or pattern in paper that appears as various shades of lightness/darkness when viewed by transmitted light (or when viewed by reflected light, atop a dark background), caused by thickness or density variations in the paper.[2] Watermarks have been used on postage stamps, currency, and other government documents to discourage counterfeiting. [5] Watermarks are devided in two types – linear, and halftone watermarks, where as for the halftone watermarks, several levels of

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transparency is observed.

Planchettes. Planchettes are tiny paper dots (0.055-in in diameter) that are embedded during papermaking and are not reproducible by scanning, photocopying, or printing (Fig..3). Planchettes can be fluorescent or non-fluorescent.[1]

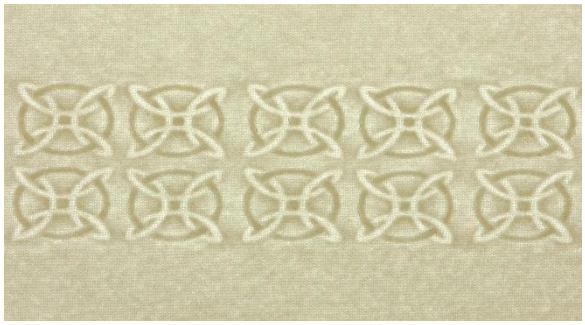


Fig. 2. Watermark.

Fluorescent planchettes change color under UV radiation;

Non-fluorescent planchettes can be removed from paper surface; resistance to removal provides evidence of counterfeiting.

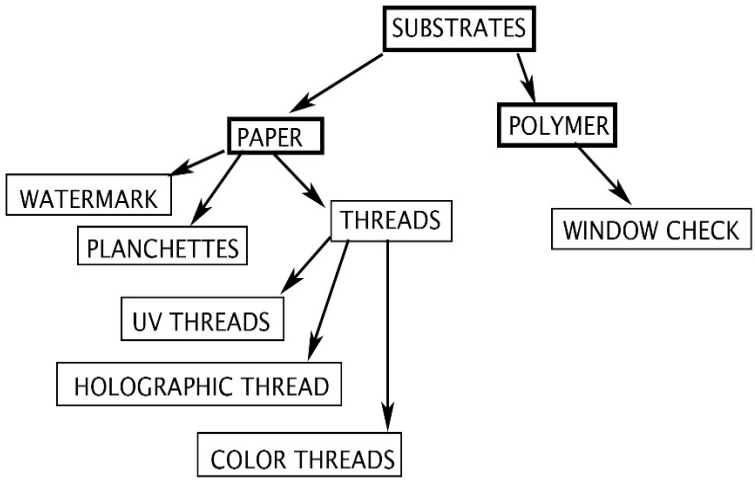
Chemically-reactive planchettes change color upon contact with an alkine solution.

Thermochromic planchettes are authenticated through contact with heat, which causes them to change color. They make it possible to verify a document's authenticity without the aid of special lamps or other tools [1].

Fig. 3. Planchettes.

Chemically reactive stains:– the paper is provided with chemically reactive compounds that provide vivid coloration upon application of chemicals used to tamper with documents.[1]

In some specific cases, substrates can be personalized and produced with certain features and unique securities in order to improve the level of protection and to prevent from counterfeiting and forgery. The security features used in substrates are given on Scheme 1.



Scheme 1. Security features in substrates.

Most banknotes are made of heavy paper, almost always from cotton fibres for strength and durability, in some cases linen or speciality coloured or forensic fibres are added to give the paper added individuality and protect against counterfeiting. Some countries, including Nigeria, Romania, Mexico, New Zealand, Israel, Singapore, Malaysia, United Kingdom and Australia, produce polymer (plastic) banknotes, to improve longevity and allow the inclusion of a small transparent window (a few millimeters in size) as a security feature that is difficult to reproduce using common counterfeiting techniques [2,10,11]. Polymer banknotes are banknotes made from a polymer such as bi-axially oriented polypropylene (BOPP). Polymer banknotes last significantly longer than paper notes, causing a decrease in environmental impact and a reduced cost of production and replacement. In November 2011 Canada joined the list of countries using polymer currency as it began the introduction of a new banknote series.

SECURITY INKS

A wide variety of security inks can be used in documents, packages, lables, and cards. In addition to security printing inks, the printer can also use

overprint varnishes and laminates to help deter counterfeiting. It should be noted that many security printing inks depend upon the absorption of UV radiation and its re-emission as visible light. Therefore, to work properly, many security designs and devices must be printed on UV-dead or uncoated paper. On other media they will only work if there are no UV brighteners in the substrates.

Fluorescent dyes are dyes which fluoresce under ultraviolet light or other unusual lighting. These show up as words, patterns or pictures and may be visible or invisible under normal lighting. This feature is also incorporated into many banknotes and other security documents. Some producers include multi-frequency fluorescence, such that different elements fluoresce under specific frequencies of light. For example there are tri-fluorescent inks that are visible at three different frequencies of the UV light. They are shown in Fig. 4 [1,6,13].

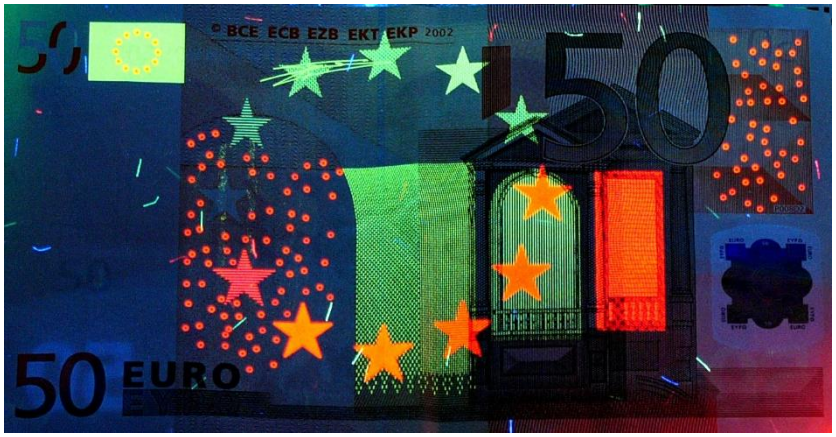


Fig. 4. UV flourescent inks.

Iridiscent inks contain metallic particles and exhibit a change of color and surface texture when viewed at different angles. They consist of a metallic or pearl-luster type of inks. The iridescent optical variable structures interact with light to give the appearance of fluctuating colors emanating from otherwise colorless matter. Iridescent inks are produced by either Fraunhofer diffraction or Bragg reflectance from multiple thin-film structures that exhibit the desired light-interference patterns [1].

Photochromic ink. Photochromic ink changes color when exposed to UV illumination, then reverts to its original color in visible light [1]. Photochromic ink is easy to verify with a UV source or natural sunlight. Inks are available that change from colorless to colored, or that change from one color to another, under UV. This ink is available for waterless offset lithography and flexography.

Phosphorescent inks: inks, with compounds that reflect light, after being lit with a certain frequency of light [1].

Thermochromic ink. Activated by temperature, thermochromic ink changes from one color to another when exposed to body heat. Documents can be verified by pressing a finger over the ink or by rubbing the printed area by two fingers to trigger the color shift. Inks can change from one color to another or from colorless to a color or the other way around (Fig. 5). Various of colors and temperatures are available on the market [1,3,9,12].

Optical variable ink. The ink changes from one color to another, being observed in a different angle (fig. 6). A common type of optically variable pigment is based on a layered optical interference structure. The interference structure typically has at least one metallic reflecting layer, at least one transparent dielectric layer and at least

Fig. 5. Thermochromic ink.

one semitransparent metal layer. Metals like aluminum, gold, copper or silver are used as the metallic reflecting layer, chemical compounds like magnesium fluoride, silicon dioxide or aluminum oxide are used as the transparent dielectric layer and metals like chromium or nickel are used as the semitransparent metal layer.

Incident white light is partially reflected at the pigment's semitransparent surface layer, and

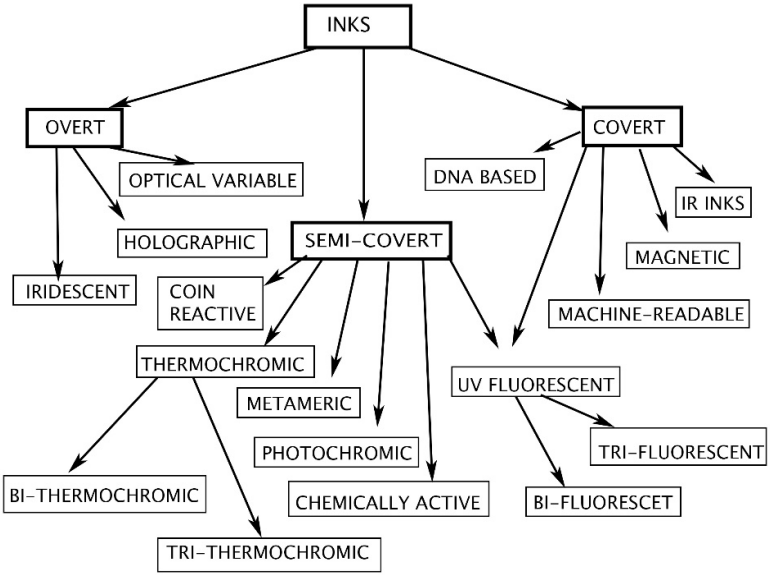
partially at the underlying metal layer. The difference in optical path between both parts of reflected light results in constructive or destructive interference, depending on the wavelength, i.e. enhances the reflectivity for certain wavelengths and reduces it for others. This spectral discrimination is perceived by the human eye as the appearance of color. For different angles of view, the difference in optical path changes, which makes the layered material exhibit angle-dependent color [6-8].

Infrared ink: they become visible, when lit with infra-red light. These inks can react to a certain frequency of light in the IR spectrum.

Machine readable inks – consist of magnetic pigments. The pigment is dispersed in a binder system or waxy compound and is applied by pressure or by heating to a film – most often polyethylene. Machine-readable inks are used in the branch of banking security due to their fast processing.[1]

On scheme 2 most of the security inks, divided in three branches: overt, covert, semi-covert can be observed.

Fig. 6. Optically variable inks.



Scheme 2. Security features within inks.

PREPRESS SECURITY FEATURES FOR EMBEDDING INTO DOCUMENTS

Prepress in security printing plays a vital roll in securing ID cards, passports and other government documents. Designers can apply a vast majority of features, with the help of computer programs, constructed only for the purpose of security printing. A whole departments in each printing house are left to work only over republish.

Microtext. Microtext, 15-90 microns high, is usually printed as a repeated alphanumeric message and at normal viewing distance appears to be a a continuous line of some geometric shape. Printers can cleverly design copy with signature lines, portrait outlines, or pictures with microline text [1].Without a microscope, microtext is difficult to be spotted out. This is an excellent deterrent against counterfeiting documents, currency, and other financial instruments such as checks (Fig. 7) [1,3,9].

Guilloches patterns. The guilloche pattern is a unique, nonrepeating spiral design that is carried out to bleed marks, so when the document is trimmed, the lines reach the edge.[1] Using a guilloche pattern as a background can be very effective to protecting a document from counterfeiters (Fig. 8).

Fig. 7. Microtext.

Fig. 8. Guilloches.

Void pantographs. Void pantograph is effective against the usual counterfeiter using a photocopier. It is an invisible or barely-visible massage hidden in the background of the print. A word such as "photocopy" will appear when the document is being copied. This technique is based on the inability of the copiers to accurately reproduce screen densities of different differing resolutions and dots angles. Unaided eye sees an even color density, unlike the photocopier [1].

Prismatic color blending. This technique involves overprinting multiple ink colors to create a third color. When applied to a document, this effect is difficult to match by scanning or copying. At first glance, prismatic color blending looks similar to split-fountain printing. The differences are apparent when two processes are compared under magnification. Prismatic blending requires at least two color printing unites on the press, while split-fountain printing requires one ink unit that is located with multiple ink color separated by a "dam" at the ink rollers [1].

Digital watermarks. The digital watermark is a digital image that is embedded in the microstructure of an existing image file, the location and structure of which is known only to the creator of the original image file [1]. When printed on paper, the watermark becomes a machine-readable feature. A specific software will be needed to see the image.

Fake watermarks: faint images of continuous tone or halftone, printed on the back side of a substrate. They imitate a real substrate watermark when observed over transmitted light.

SECURITY PRINTING TECHNOLOGIES

Security printing devices are often categorized as either "overt" or "covert". Overt security devices are integrated into documents and are designed to be easily detectable by the unaided eye under normal daylight or office lighting. Covert devices are usually hidden in the document's design. They can be machine-readable or require special optical aids to be detected and verified.

There are a wide variety of technologies that are used to print materials. The main industrial printing processes are:

Offset lithographic printing. This is the most popular and used printing method in all spheres of printing production. The revolution that came with Offset printing has brought a wide variety of possibilities. Not only that it has increased the speed and revolutionized the history of slow and complex printing, but it has played an important roll in security printing as well. One of the advantages over other forms of printing, is high and consistent image quality [3,16].

Offset lithography is a process used for printing on a flat surface, using plates. An image is transferred to an offset plate which is chemically treated so that only image areas (such as type, colors, shapes and other elements) will accept ink [16].

In security printing, offset machines are most suitable for printing in details. It is great for intricate details such as guilloche patterns and security printing artwork. Another option is the split duct printing that gives a unique security mark and can be spotted for unarmed eye. Printing with UV

an IR inks is also a security feature, commonly used in the production of tickets, shares, etc.

Flexography (often abbreviated to flexo) is a form of printing process which utilizes a flexible relief plate. It is essentially a modern version of letterpress which can be used for printing on almost any type of substrate, including plastic, metallic films, cellophane, and paper. It is widely used for printing on the non-porous substrates required for various types of food packaging (it is also well suited for printing large areas of solid colour) [3,15].

In security printing, this method is especially good when printing inks such as thermo-chromic or where you need to carry more ink to make the security feature more effective. Unlike offset printing though, flexo is not that detailed and cannot be used for printing micro lines and details.

Intaglio printing. Intaglio is a printing technique in which the image is incised into a surface. Normally, copper or zinc plates are used, and the incisions are created by etching or engraving the image, but one may also use mezzotint. In printing, the surface is covered in ink, and then rubbed vigorously with tarlatan cloth or newspaper to remove the ink from the surface, leaving it in the incisions. A damp piece of paper is placed on top, and the plate and paper are run through a printing press that, through pressure, transfers the ink to the paper.

The very sharp printing obtained from the intaglio process is hard to imitate by other means. Intaglio also allows for the creation of latent images which are only visible when the document is viewed at a very shallow angle [3,5,9].

Screen printing is a printing technique whereby a mesh is used to transfer ink onto a substrate, except in areas made impermeable to the ink by a blocking stencil. A blade or squeegee is moved across the screen to fill the open mesh apertures with ink, and a reverse stroke then causes the screen to touch the substrate momentarily along a line of contact. This causes the ink to wet the substrate and be pulled out of the mesh apertures as the screen springs back after the blade has passed. [5]

In security printing, screen is very often used for features needing a higher ink thickness. Such security features are optical variable inks and color-shifting inks.

CONCLUSIONS

By nature, the security printing industry is a niche marketplace of unique, one-of-a-kind processes, a marketplace that attracts suppliers and manufacturers with specialty and novelty materials, advanced processes, and other enabling technologies outside the realm of general commercial printing.

Future trends in Security Printing are getting on the way with the new nanoprint technologies, printed electronics and revolutionary inventions in digital printing.

These and many more are to become the new security printed features in order to protect the public from illegal activities and bring a more safe and secure future of printed documents.

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ОБЗОРЕН ПРЕГЛЕД НА ВИДОВЕТЕ ЗАЩИТИ В ЗАЩИТЕНИЯ ПЕЧАТ И ТЕНДЕНЦИИ ЗА БЪДЕЩОТО ИМ РАЗВИТИЕ

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(Резюме)

Още една от ключовите промени в индустрията е възможността за печат върху невсмукващи субстрати, като полимери - биаксиално ориентиран полипропилен. Благодарение на тази комплексност в химичните структура на субстратите, документите и банкнотите имат по-голяма износоустойчивост и по-ниска ставка на подправяне.В настоящата разработка е направен обзорен преглед на защитения печат и са описани различните методи и печатни технологии за защита на документи, етикети и опаковки. Разгледано е тяхното приложение и тенденции за бъдещо развитие.

Защитените продукти представляват голямо разнообразие от различни видове ценни книжа и документи. В зависимост от вредите, които фалшифицирането и подменянето могат да нанесат върху благополучието и финансовата стабилност на притежателя им, се определя степента на защита на отделните продукти.

С цел да се намали възможността за подменяне и фалшификация, печатарската индустрия разполага с широк обхват от защитни методи, подбрани в подходящи комбинации, благодарение на които се постигат високо защитени документи. Защитните средства се категоризират като явни, скрити и машиночитаеми.