



## ANALYSIS OF SECURITY PRINTING FEATURES ACCOMPLISHED BY SHEETFED LITHOGRAPHIC OFFSET PROCESS & SHEETFED SCREEN PRINTING PROCESS

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### ABSTRACT

This document gives information about security printing, security features based on different elements as substrate, printing processes and Ink and security printing applications.

**KEYWORDS:** Security Printing, Security Features, Conductive Ink, Spectrophotometer.

### INTRODUCTION

Security printing deals with printed document, certificates, legal documents and all kind of certificates given for authenticity, ownership or educational achievements. There are many steps and different features involved to secure the document. Security printing is the field of the printing industry that deals with the printing of items such as banknotes, passports, tamper-evident labels, stock certificates, postage stamps and identity cards. The main goal of security printing is to prevent forgery, tampering, or counterfeiting.

There are many features which used for security and they get involved in different steps production, i.e. security involved at substrate level when it is manufactured, the designing elements which are involved in document for security, the printing processes and special applications used and at last different post press special applications used. The contents of security printing which are incorporated in document security are differentiated on the basis of where and how these involved and added. There are different aspects where the security is involved as

- Substrate Based Security features
- Diffraction Based Security features
- Interference Based Security features
- Printing inks
- Printed Security patterns

### SECURITY FEATURES

#### A) Substrate Based Security

It includes the substrate used for secured documentation; there are papers, plastic and synthetic paper. As a Substrate, On it's account Paper have security features such as it's manufacturing contains called composition, watermarks, chemical reactance of substrate to different chemical families, security fibers which are embedded or woven in paper layers, plan chets having different colours and UV glow. All these features are incorporated at the time of substrate manufacturing but beside of all these further few

features are added later in paper substrate such as fine mechanical perforation, laser perforation of customized size. Paper substrate have impactive image in security system, beyond all these features the physical touch of paper, it's sound, colour, size of document all are very first check point of any document inspection. Any counterfeit document catches observers attention by it's first look, it's feel in hand; that's why Feel, Colour and sound of substrate also important just like a security features.

Plastic Substrate is introduced to us very recently, as the plastic money comes in to demand for more secured, classified, and fast money transactions with the help Internet Networking. Plastic substrate does not carry conventional security features, it is totally different material so they relied on the magnetic stripe and, later, on hot-stamped optically variable devices (OVDs), such as holograms adhered to their surfaces. Apart from plastic card the development and application of plastic bank note is also in progress. The substrate which is in process of development for currency it is incorporated with lightmarks just like a watermark, laser engraving, optical variable devices, interference based polarizing windows, RFIDs, blind embossing or engraving, embedded transmission holograms.

#### B) Ink Based Security

There are types of ink which have special properties related to physical aspect of chemical aspect. The response of these ink are in relation with environmental chance of ink as change in temperature e.g. Thermochromic ink - reversibly change color with temperature. In security applications, these inks can be inspected in first line by warming to body temperature, at which they become transparent and the color temporarily disappears. Change in chemical composition like in physical touch with chemicals, e.g. Fugitive ink-printing disappear once bleaches or organic solvents are applied. The disappearance of the background printing exposes the attempt to alter variable information.

With reference to the observer, few inks have characteristics which depends on viewing conditions of ink e.g.

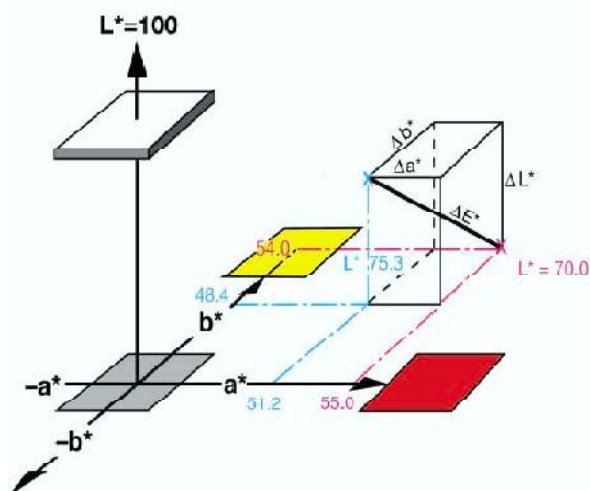
- Metameric ink**- contain foreground and background image elements whose color contrast is practically invisible under white light illumination, but whose contrast becomes manifest in another type of illumination.
- Photochromic ink** - change color under UV exposure.
- Optical variable ink** - Optical variable inks display a notable change in color with angle of observation and illumination.
- UV Ink** -Printed image appeared or disappeared change under UV exposure.

Few security inks have there in build characteristics as they response dramatically after printing e. g.

- Penetrating ink, Bleeding ink** – printed images appeared through the substrate as ink get absorbed in substrate.
- Conductive ink, Magnetic ink** – ink contains ferric oxide, a material which response to the electric field and generate a electric pulse as it's Identification. In Magnetic and Conductive ink printed ink density have major role in it's proper character functioning and originality of containing document.
- Fluorescent dyes**-Dyes which fluoresce under ultraviolet light or other unusual lighting.

### C) Spectrophotometer

In the spectral measuring process the total visible spectrum from 380 to 780 nm is measured. The light reflected from a printing ink is separated into its spectral components by means of a diffraction grate and measured by an array of sensors. With spectrophotometer it is possible to exactly describe the measured colour. Then colour difference is calculated i. e. Delta E. The colour difference is a measure of the distance between two colour locations in the colour space .(e.g. between original and printed sheet.) With colour measurement function density of printed colour can also be measured with spectrophotometer.



### D) Diffraction Based Security

- Noniridescent Optical Variability** - Optical variability was described as a property of transitory images. It simply explained as display of optical variability in watermark, a positive to negative contrast swap between observation in transmission and diffuse reflection.
- Foil Printing** - Obviously, metallic foils are optically variable. Foil printing, a straightforward hot foil stamping technique, generally is beyond the capacity of amateur counterfeiters.
- Retroreflective Films** - A retroreflector reflects the incoming light back into the direction of the source, a phenomenon that we know from road signs. Because the definition of optical variability is the significant change in appearance of an object depending on the angle of illumination and observation, retroreflective films are optically variable devices by definition.
- Diffraction Optically Variable Image Device** - All DOVID security structures are produced by means of embossing or casting. Casting is similar to embossing, but the shim is pressed into a viscous coating, which is then cured, usually by ultraviolet radiation, to the required hardness. These processes allow the mass production of security features at low cost. Embossing is commonly carried out on rotation machines with rolling presses at speeds from many tens up to several hundreds of meters per minute.

### D) Printed Security Patterns

- Guilloches** - geometric fine-line pattern, is an architectural ornament formed from two or more interlaced bands with openings containing round devices or a pattern (as on metalwork) made by interlacing curved lines. The term guilloche is widely used in the security printing industry to denote intricate ornamental borders and emblems consisting of fine curved lines. Guilloches have become symbolic for the notion "valuable document."
- Microprinting** - consists of very fine lettering, beyond the resolution of the unaided human eye. While small lettering of sufficient contrast is legible without magnification down to characters of about 0.5-mm high, the height of microprinted characters is smaller, even down to 0.15 mm.
- See-Through Register** - Modern offset printing machines allow the printing of spatially related image elements in seamless front-to-back register on both sides of a document. If held against the light, the register of front and back image elements is revealed.
- Engraved Portraits** - The intaglio printing process allows the printing of high-resolution line portraits with high line contrast, and the superior resolution and contrast of intaglio printing cannot be achieved with any other printing technique. The security value of engraved portraits was further based on the acknowledged difficulty associated with re-engraving a portrait that exactly looks like the original. This is considered

especially difficult because of the highly developed human ability to recognize faces.

- e) **Transitory Images** - Transitory images are based on the application of relief patterns to document substrates. Such patterns can be either intaglio printed relief patterns or blind-embossed relief patterns. Transitory images are characterized by the distinct changes in contrast of the printed design, depending on their angle of observation and illumination.
- f) **Artistic Screening** - Conventional halftone reproduction by constant screen dot shape is replaced by customized dot shape used for halftone reproduction. Artistic screening takes this idea a step further and instead of using dots as a halftone, graphics and even text can be used to build the image.
- g) **Constant Screen Angle** - Color reproduction in printing techniques are done by different halftone color screen angles for that individual process. The printed images show the color gamut of individual process but by using constant color screen angle color gamut's ranges can be manipulated.
- h) **Numbering Security Features** - A number of features can be incorporated with numbering to provide security to documents. Two of the most popular are Rainbow numbering and Bleed-through numbering. Rainbow numbering, A special technique that gives the number a rainbow appearance.
- i) **MICR coding** - Old cheque numbering contains fix coding system of banking system but now a days because of magnetic conducting ink's cartridges, shifts mechanical numbering process to high speed inkjet printing process which have variable coding, customized identification as required by consumer with max security coding.
- j) **Variable data printing** - The new field that provides no. of options for personalized data reproduction, it includes barcode in 1D, 2D, 3D or Matrix (QR code) also. We can have the combination of Variable text matter in combination with Barcode, MICR coding, Images etc.
- k) **RFID tags** - With the advent of RFID, it is possible to insert extremely small printed RF-active devices into the printed product.

### EXPERIMENTAL SETUP

A customised test chart comprising of different print targets is printed on multicolour offset printing machine and screen printing machine. The printed results are observed and analysed for Dot Gain and Density. The difference is measured using software based spectrophotometer. The differences are determined with halftone scale, colorimetric areas, trapping, gray scale etc. which are produced during plate making, positive making and printed out and then measured using a densitometer or spectrophotometer.

SNo	Parameters	Detail
1	Machine 1	Mitsubishi 4xr (4 colour Offset m/c)
2	Machine 2	GF- Nano print Plus (Screen)

3	Printing Seq.	K C M Y
4	Paper 1	120 gsm super sunshine Maplitho
5	Screen rulling	85 lpi, 175 lpi
6	Screen angles	Offset (Y-90, K-45, C-15, M-75), Screen (C-82.5, M - 142.5, Y - 7.5, K - 22.5)
7	Ink	Gous, Ulano
8	CTP	Voilet CTP (Technova)
9	Software	MS Excel for calculations & CorelDraw for design
10	Instruments	Xrite ilpro Spectrophotometer with ProfileMaker



### TEST CHART

Test form consisted of following elements -

1. Dot gain scale with Trapping percentage scale.
2. Continuous scale Trapping percentage scale.
3. Image 1 – Halftone B/W image
4. Image 2 – High-key image
5. Image 3 – High contrast image
6. Image 4 – Low-key image
7. Image 5 – Oil painting
8. Image 6 - Natural colour, Full colour, 4c gray, B/W
9. Image 7 - True colour - Full colour, 4c gray, B/W
10. Image 8 – Skin tone - Full colour, 4c gray, B/W
11. Image 9 – Gray tone - Full colour, 4c gray, B/W
12. Colour patches – for gamut mapping
13. Micro text – font size 0.4 pt – 1.25 pt
14. Micro Line – 0.01 to 0.2 pt
15. Reverse lettering and lines
16. Registration mark – with scale and overprints
17. Customised control strip with star target, CMYK patches, gray balance patch, trapping patch, Halftone patch

**PROBLEM STATEMENT**

Every security features have different characteristics and need different printed parameters, for that it is tried to have

**ANALYSIS**

scope of process's printable range to get desired properties of features using two or more process combination.

1. 1<sup>st</sup> Test Run carried on offset and screen printing m/c

Sr. No.	Density							
	K (1.9-2.2)		C (1.35-1.45)		M (1.35-1.45)		Y (0.9-1.1)	
	O	S	O	S	O	S	O	S
1	1.23	1.97	1.01	1.52	0.95	1.39	0.76	1.19
2	1.19	2.01	1.05	1.48	0.97	1.4	0.79	1.21
3	1.21	1.93	0.97	1.49	0.92	1.42	0.8	1.18
4	1.26	1.95	1.1	1.47	0.96	1.41	0.77	1.21
5	1.23	1.94	0.95	1.48	0.93	1.39	0.79	1.2
6	1.2	1.97	0.98	1.51	0.89	1.42	0.81	1.21
7	1.24	1.94	1.03	1.49	0.94	1.43	0.78	1.17
8	1.22	1.98	1.07	1.47	0.98	1.39	0.79	1.19
1 (100)	1.27	2.1	1.08	1.49	0.97	1.4	0.79	1.21
2 (100)	1.25	2.07	1.1	1.53	1.02	1.42	0.83	1.19
Avg.	1.23	1.986	1.034	1.493	0.953	1.407	0.791	1.196

2. 2<sup>nd</sup> Test Run carried on offset and screen printing m/c

Sr. No.	Density							
	K (1.9-2.2)		C (1.35-1.45)		M (1.35-1.45)		Y (0.9-1.1)	
	O	S	O	S	O	S	O	S
1	1.75	2.29	1.29	1.52	1.19	1.43	0.84	1.21
2	1.73	2.26	1.25	1.55	1.24	1.47	0.88	1.22
3	1.78	2.31	1.28	1.53	1.23	1.45	0.91	1.19
4	1.77	2.27	1.26	1.57	1.28	1.48	0.87	1.2
5	1.75	2.29	1.26	1.54	1.25	1.46	0.86	1.19
6	1.72	2.33	1.29	1.56	1.23	1.42	0.84	1.21
7	1.76	2.29	1.28	1.53	1.27	1.44	0.83	1.18
8	1.77	2.28	1.26	1.52	1.24	1.47	0.85	1.19
1 (100)	1.74	2.3	1.25	1.51	1.26	1.45	0.87	1.2
2 (100)	1.78	2.28	1.28	1.52	1.25	1.47	0.88	1.22
AVG.	1.755	2.29	1.27	1.54	1.24	1.45	0.86	1.2

**CONCLUSION**

Different printing processes gives different ink deposition that results in considerable difference in densities. In case of Security printing inks, amount of ink deposited on print plays significant role on performance of ink. Metamaric ink, Optical variable ink, Conductive ink, Magnetic ink, Thermochromic ink etc. need to have proper ink density or Ink deposition on to print to give proper performance for

faithful authentication of document. I.e. Density of ink gives significant effect on ink performance.

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