EXPLORING LOCAL MATERIALS FOR THE DEVELOPMENT OF TRANSPARENT THERMAL INK (TTI); FOR SECURITY PRINTING

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Abstract

Most official documents or highly valued paper documents use by government and the private sector in Nigeria are vulnerable to being counterfeited by fraudsters. This is so because little or no attention is given to document protection, as a result, document forgery persists in Nigeria. Some of the major security features that were found on most valuable documents in Nigeria range from seals, blind embossed logos, or text, and computer generated images faintly printed on documents as watermarks. With the advent of desk top publishing facilities and some readily available embossing and seal-making devices, such security features have ceased to be security components. This experimental study sought to proffer solution to the problem of document forgery in Nigeria by using locally sourced materials to develop anti-copy ink that can be used to create blind-images on paper document as security component. The materials used for the experiment include; lemon juice, Calotropis resin, urine, and mentholated spirit. They were combined to develop the transparent thermal ink (TTI). The research design employed for the study is laboratory experimentation and the major findings include: images created with the ink are not visible; but when heat was applied on the blind images they appear brown in color, heating devices such as hot pressing iron, laminating machineand other heat sources can make the images change color. The TTInk can have wide application; it can be used as anti-copy, color change, and thermal ink for document protection. Keywords: Counterfeiting, document protection, security features, blind images.

Introduction

Corruption is the perversion of integrity or state of affairs through bribery, favour, or moral depravity, it takes place when at least two parties have interacted to change the structure or processes of society or the behaviour of functionaries in order to produce dishonest, unfaithful or defiled situations, (Otite, 1982). In Nigeria corruption thrives both in government and the private sector. When government regulations become pervasive and top officials have discretion in applying them, individuals take advantage of such lawlessness to commit all sorts of criminal acts like tampering with valuable paper documents through counterfeiting to achieve self-centered goals. The advent of desk top publishing devices and design software has enhanced document theft in a proportion that can only be imagined. The art of forgery and counterfeiting of valuable paper documents such as paper money is as old as the art of banknote printing.

Forgery has been a major threat to banknote printers from its invention by the Chinese around the 7th century. A lot of research works have been conducted in the area of security design and printing with a view to curbing forgery. One of the oldest security features employed by paper producers is watermark.

Security measures, Materials, and Features

Watermarks

Document forgery is as old as the invention of paper money and one of the earliest cases of forgery is that of Black Tulip (Czech Ctizine) and Candido Saures.(Portuguese).They belong to the South American gang that began operation in 1966. Swedish banknotes were extensively forged and in response, the Bank of Sweden produced new notes that were thought to be of high quality by introducing watermark (BANCO) on the new notes. In 1772, watermarks were seen on Saxon banknotes. The use of watermarks as a security feature became common in the second half of the 19th century. Joe, (1990), sees watermark as any kind of translucent or color pictorial element which could be a shape, Logo, and or acronym created on paper and used as a security check on any highly valued paper document. Watermarks are faint designs on paper discernible by placing the paper on or holding it against light source.

Coombs,(2002), noted that, the 19"' century witnessed an unprecedented development in the field of document protection, new techniques and materials came to fore with a view to safeguarding banknotes and other highly valued paper documents, they include:

Watermarks

- Multi tone watermark
- Colour fibre on paper
- Planchets or security threat or wire
- Digital watermark for electronic transmission
- Fluorescent paper Inks
- Special printing inks
- Fluorescent inks
- Colour change inks
- Thermal inks
- Anti copy inks
- Raised feel inks
- Photo chromic pigments
- Dot structure moire by means of screens
- Over print films
- Rainbow inks

Holograms

- Ken gram
- Optically variable devices (OVDs)
- Digital pixel hologram
- Computer generated images

Laminates
- Foil or ken gram
- Distractive laminates
- Numbered or logo foil
- Magnetic tapes

Printing techniques
- Intaglio process
- Letterpress
- Offset liyhography
- Orloff
- Dryography
- Micro print

Others
- Blind stamping
- Biometrics
- Direct write methods

Problem statement and objectives

The consequences of corruption and organized crime (forgery) are numerous. They include; undermining national development, enormous loss of revenue, undermines economic and political efforts, erodes confidence in foreign investors, and so on. Committing all these crimes is most often than not enhanced by falsification of valuable documents by way of counterfeiting. The specific problem of this study is the development of anti- copy ink that can be used as a security guard to reduce and or eliminate document forgery in Nigeria.

One of the objectives of the study is to: explore local materials for the development of security printing inks which can be used to create invisible (anti-copy) security features on paper, protect valuable paper document from being counterfeited, create awareness in average Nigerians on the need to protect paper document with security features.

The study addressed the following research questions:
Are there possibilities of using locally sourced materials to develop security printing inks?
Can the security of paper document be enhanced by using the locally developed security inks?
In what ways can the findings of the study create awareness in the general public?

What led to the formation of anti-corruption agencies locally and internationally is the desire to eradicate corruption and enshrine rule of law, this need provides justification to the study, as its primary focus is to contribute in the eradication of corrupt tendencies in all its ramifications. The scope of the study is limited to the development of anti-copy thermal inks using focally sourced materials such as lemon juice, Calotropis resin and urine.

Studio experimentation was employed for the study several tests were conducted with different materials. One of such materials is Calotropis.

Experiment one TTI Calotropis Materials

PLANT; CALOTROPIS
BOTANICAL NAME:- PROCERA (AIT)
FAMILY:- ASCLEPIACEAE
LATEX: WHITE AND MILKY
Transparent glass bottle
5mml syringe

- Test tube
- Glass cup
- Fine fibre filter
- 80gm bond paper
- Points 2,3 and 4 rotring pens

Ink Mixture (A)

- Calotropis latex.....2milligram
- Human Urine.....2milligram
- Mentholated Spirit.....2milligram

Dennis (2005) notes that free metal atoms vaporized in a flame, or in an electric furnace, to their ground states, absorb light at characteristic frequencies in the UV-visible region of an electromagnetic spectrum. This informed the use of Atomic Absorption Spectroscopy to analyze for the presence of metal atoms in the Transparent Thermal Ink mixture after it has been vaporized in a flame. Using the Atomic Absorption Spectroscopy analysis technique, certain trace elements were identified in the mixtures, they are tabulated below.

Mixture A (Calotropis Latex)

Elements	Concentration	Abs.	Pos.	Actual Cone.	ActualCone. Unit
Co.	0.4039	0.0067	32	0.4039	ppm
Cr.	0.0226	0.0009	32	0.0226	ppm
Fe.	0.4747	0.0128	32	0.4747	ppm
Zn.	0.2117	0.0390	32	0.2117	ppm
Mg.	0.0133	0.0042	32	0.0133	ppm
Cd.	0.0281	0.0027	32	0.0281	pmm
Ni.	0.0281	0.0027	32	0.0281	ppm
Pb.	0.1631	0.0011	32	0.1631	ppm
Cu.	0.0301	0.0040	32	0.0301	ppm
Mn.	0.0633	0.0126	32	0.0633	ppm

Procedure

The method used in extracting the Calotropis latex was by breaking the leaves and collecting droplets of latex into a test tube. Five minutes after collecting the latex it became thick, fresh natural lemon was then used to enhance viscosity or improve fluidity of the mixture. Fine cotton fabric was used to filter the mixture before use. Rotring pen point 3 was used to test the ink on bond paper, the purpose is to test the absorbency of the bond paper, whether the latex could

permeate the filler used on the paper or not and to test if blind images can be created on bond paper with the ink.

Linear images were drawn on paper using the Calotropis ink, the images were allowed to dry for 10 to 15 minutes; thereafter heat is applied on the images which changed from light cream to dark burnt umber (a shade of dark brown). The Calotropis latex resin can be improved upon and used as thermal ink since the colour changes with the application of heat. This can be done by bleaching the latex to a clear and transparent solution that can be fed into a pen or developed into a special printing ink that cannot be easily seen with naked eyes when printed unless heat is applied on it.

If the latex is bleached and developed into writing ink, it can be used as security ink for "direct write" on valuable paper document. Hampo, (2002) is of the opinion that security features in the form of design elements printed in anti-copy ink which are bio-based can be introduced on some valuable paper to check forgery. An attempt was made by the researcher to use screen-printing technique to print with the Calotropis latex as printing ink. The words SECURITY CHECK were typesetand exposed on a 150 line screen mesh. De-coagulated latex was forced through the 150-line mesh using a squeegee. The impression (SECURITY CHECK) was transferred from the mesh to A4 bond paper. After the impression dried, heat was applied using two methods:

One - heat from an electric pressing iron was applied on the dried impression for two minutes and the impression changed from light cream color to dark brown, but the two words were not very legible. Perhaps because the mixture (Lemon and Latex) was too watery, so the image did not register properly on the paper, this affected the legibility of the image after the application of heat.

Two - heat from hot charcoal was also applied on the dried image by exposing the paper upon which the impression was made over the hot Charcoal, Within three seconds, the image came out but the clarity was the same as the case of the electric iron.

When the screen printed images were compared with those directly drawn with a rotring pen, it was found that the images from the later were sharper and more legible. Computer- generated watermarks are usually done with a very low resolution, which reduces their tonal value. This is because the dot per square inch (DPI) is low. When hard copies of such computer- generated watermarks are printed in whatever colour, any copying device can pick them. Scanners and photocopy machines easily recognize them and make copies of them because they are printed in spot color in form of dots that are widely spaced off from one another.

Some special papers are water marked with translucent images or logos. These translucent images were made at the point of production when the paper is formed. Watermark is often used on bank notes and some highly valued documents. Translucent images on paper are considered as security features because they cannot be copied by any photocopying machine or scanned at any resolution especially when there is an over print on it.

Photocopy Test of TTI-Calotropis

The BW ink screen-printed images were tested on three different copying machines. The reason for testing the prints on different machines is to ensure the validity of the tests. A new photocopy

machine was used for the first test. Three photocopies were made, but each paper had no image transferred on it, meaning that the transparent images are anti-copy.

Scanning Test of TTI-Caloptropis

As in the case of the copy test, different brands of scanners were used for the test, (Hewlett Packard HP, Mercury and Mustek). The images were scanned at onethousand dots per inch (1000 dpi). When the scanned images were previewed on the monitor, only a blank sheet of paper was seen, and when a hard copy print out was made no image was seen on the paper.

Experiment two TTI-Lemon Juice Materials:

- Transparent glass bottle
- 5mml syringe
- Test tube
- Glass cup
- Fine fibre filter
- Empty deskjet cartridge
- HP DeskJet D1560Printer
- Grandextra Laminating Machine
- 80gm bond paper
- Points 2,3 and 4 rotring pens
- HP Laptop

Mixture B (Lemon Juice)

- Lemon Juice.....5milligram
- Human Urine.....5milligram
- Mentholated Spirit.....2milligram

Elements	Concentration	Abs.	Pos.	Actual Cone.	Actual Cone. Unit
Co.	0.2894	0.0048	33	0.2894	ppm
Cr.	0.0553	0.0022	33	0.0553	ppm
Fe.	0.0816	0.0022	33	0.0816	ppm
Zn.	0.1249	0.0230	33	0.1249	ppm
Mg.	0.0108	0,0034	33	0.6480	ppm
Cd.	0.0281	0.0027	32	0.0281	ppm
Ni.	0.0990	0.0095	33	0.0990	ppm
Pb.	0.3262	0.0022	33	0.3262	ppm
Cu.	0.0234	0.0031	33	0.0234	ppm
Mn.	0.0582	0.0116	33	0.0582	ppm

Procedure

Hp deskjet Dl 560 printer was used to test the Transparent Thermal Ink (TTI). The color cartridge of the printer was washed clean with warm water and mentholated spirit to rid it of magenta, yellow and cyan that came with the cartridge. The empty cartridge was then fitted in to the printer to test print a block of text, the test show no image or text on it was printed. The

Transparent Thermal Ink was then fed into the yellow chamber of the color cartridge using a syringe and fitted into the printer. Thereafter, the print came out blank but with some glossy spots and undefined lines that are neither readable nor legible. Plate one is the cartridge used for testing the TT Ink.

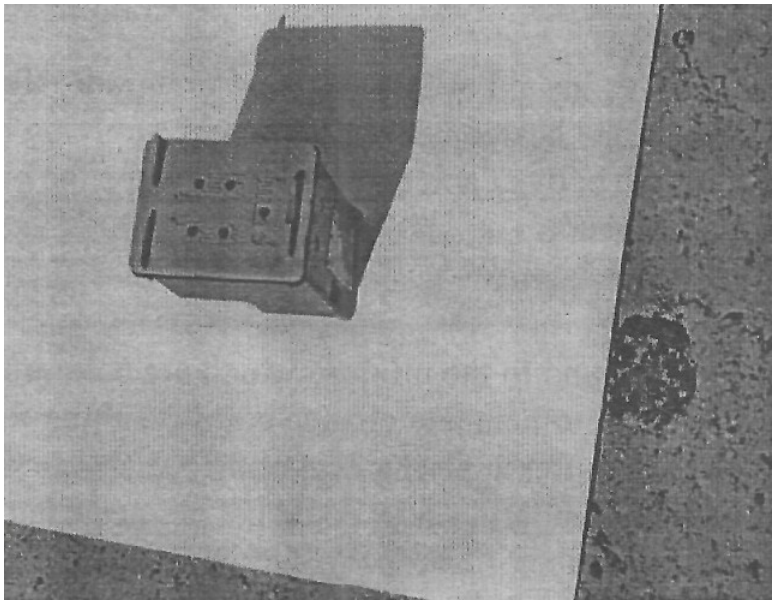

Plate 1: Shows were the TT Ink was fed into the cartridge

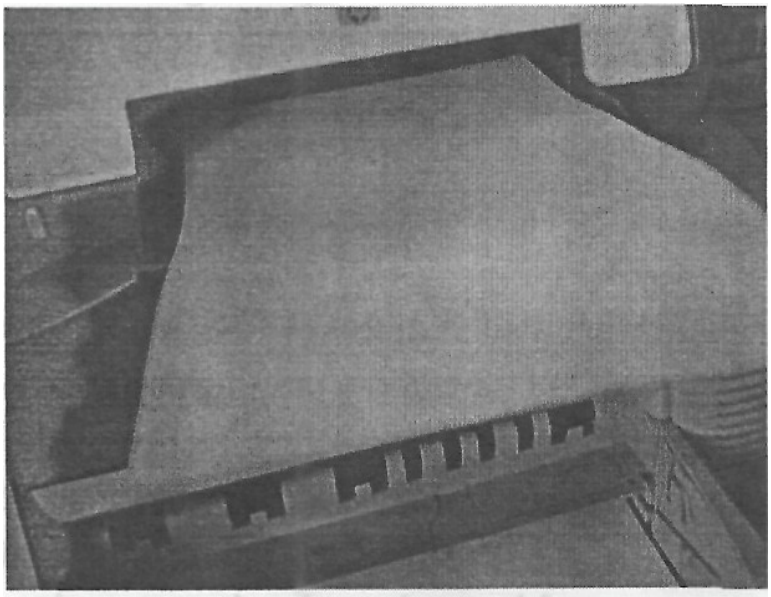

Plate 2: Shows the blind print out of text

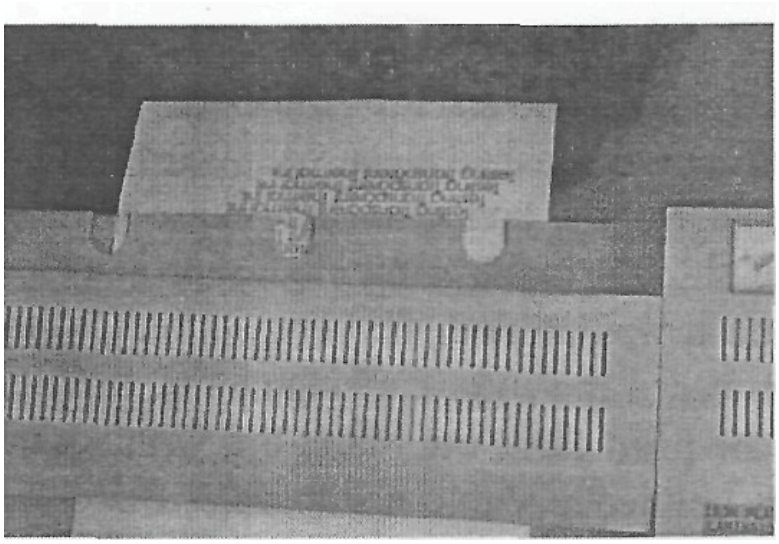

Plate3: Shows the body of text when heat is applied.

Grandextra laminator was heated at 200 degree Centigrade, the blind print out was then passed through the heated laminator thereby applying heat on the blind printed text. A dark brown body of text revealed itself when the paper came out on the other side of the laminator.

Findings

Trace metal elements found in the mixture which are colorants in nature (Co., Cr., Fe., Cu. Mn.etc.) react to heat and change color resulting to the dark brown color seen on the print out after applying heat on it.

The result showed that Euphorbia latex could not permeate the sizing chemicals used on the surface of the paper.

The absorbency of the paper is low

Calotropis latex can be used as screen printing ink because it passed through the holes of the mesh used Calotropis ink could be developed into ANTI-COPY INK and use as THERMAL INK. Calotropis ink can be used as a security printing ink for DIRECTWRITE

Conclusion

It can be concluded that both mixtures (TTI Calotropis and TTI Lemon Juice) could be used as thermal inks for security printing purposes. Again, the Calotropis ink can be bleached into clear and transparent ink that could be used as anti copy ink, which can be secretly used on paper document for security purposes. Micro design elements could also be created with TTI on documents such that it would be difficult for any counterfeiter to detect let alone reproduce it illegally. It could also be used as direct write ink for making secret signature on paper.

Suggestions:

African Security Printing and Minting companies and other relevant agenciesshould embark on forensic research and development to combat counterfeiting.African Governments should adopt document protection as a way of curbingdocument theft on the continent.

African print based researchers should intensify efforts in the area of documentprotection

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