

Intellectual Reactance of Ink

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Abstract: *In the era of brand promotion, brand identity and packaging developments, printed image or the data provided on package, it acts as informing, legal and authorizing matter for product. Printed matter whether it is graphical illustration, numerical figures or coded signs, all these are provided to enhance product appearance and increase product coverage. To enhance appearance or identity of product label plays an important role and now a day these labels are become interacting and smart, which gives the information about product, package and condition of product i.e. whether you can consume or use this product or not. These labels have all these smart interacting or indicating features because of the ink which use to print these labels. Using different physical, chemical and optical properties of ink with combination of different printing processes, we can have many indicating or interacting features in printed labels. Here we will discuss different inks used many application according to characteristics of inks.*

Keywords: Thermochromic materials, Photochromic materials, Fluorescent materials, Metal nanoparticles, Photoinitiator

1. Introduction ^[1,2,3]

When It's a simple fact that most people don't think often about printing ink, and yet it plays an important role in our daily lives. Each day ink appears on thousands of pages of newspapers and magazines, catalogues and brochures. It is on the products that line the shelves of the supermarket, the hardware store and office supply outlet. From the bar code on a price tag to the vinyl flooring in our kitchens, from the greeting on our birthday cards to the billboard beside the road, we rely on printing ink to educate, inform, and entertain us, and to make our lives easier and more enjoyable.

Ink is a primary tool used to convey a message and give decoration to a substrate. For this to occur an ink must have specific properties if it is to perform properly. It is of no value if it will not transfer to the substrate or adhere in a proper manner. Ink makers must cater for a wide variety of requirements and retain the ability to be flexible in what they manufacture. The contents of any ink are dependent on the conditions under which the products are to be printed and the end use requirements of the printed piece. At its basic definition ink is a combination of components mixed together to form a fluid capable of printing from a printing press. Printing ink is a dispersion of a colored solid (a pigment) in a liquid, and it is formulated to produce an image on a substrate. Solutions of dyes in water or other liquids are usually considered to be writing inks, not printing inks, although today ink jet printers use such materials. Some flexographic inks for special applications are also colored with dyes. Dry or liquid toners such as those used in electrostatic printing are not usually considered to be printing inks, but they are discussed in this book. In order to make the ink suitable for producing an image on a commercial printing press, other additives must be incorporated in the formula.

Term "Intellectual Reactance" explains response of ink properties or characteristics of composite ingredients added in ink with effect of Physical, Chemical or Environmental changes on 'Printed area' or in surrounding of printed area i.e. by direct or indirect effect of these factors. The changing reaction or Reactance of ink, it's an indicator or it's an evidence of fulfilment of purpose of used of ink having

special characteristics. The reason of changes shown by ink or The Reactance have Thoughtful, Scientific explanation and definite indications and identifications. Use of ink characteristics and reactance of ink have considerable recognition as for authentication of secured documents, for legal evidence in educational and commercial certificate, for health advisory in pharmaceutical, food cosmetic industry. It serves the purpose of making brand identification, avoid duplication of products and making hold on market and client. Characteristics which have intellectual reactance for observer achieved by adding different ingredients in basic formula of ink which serves as printing medium in desired printing process and give definite reactance at time of inspection. To check characteristics or special features of ink inspection techniques are developed having three stages of inspection procedures. First line inspections are carried out without any additional tools, generally by the general public. Typical first line security features are; watermarks, intaglio printing, security threads, holograms, optically variable ink and registered printing. It must allow the discovery of most counterfeits that use public security features. In first line security inspection of documents or products, various aspects of color play a dominant role. In the printed design, colors are chosen so that they cannot be truthfully copied with color copier and desktop systems. Color conveys messages to the observer about value and authenticity. In second line inspection, the document is checked with tools, generally by trained inspectors, such as bank tellers and cashiers. Second line security features include magnetic inks, barcodes, (ATM) and money changes equipment are also considered second line inspections. In second line inspection, the use of simple equipment contributes to the conformation of the authenticity of a document. Equipment include can be magnifying glass, ultraviolet sources and a white light beam. It also includes tools for automatic detection of counterfeited or forged documents, these tools may be complex or relatively simple like Card authentication method (CAM) reading device. Third line inspection involved investigations by forensic experts, generally with sophisticated equipment and most often in a laboratory or in a dedicated inspection facility. This inspection makes use of more specialized equipment, such as spectrophotometer, microscope, infrared cameras and chemical indicators to confirm suspected

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counterfeits or forgeries. These investigations can be destructive.

The reactance expected from ink as a characteristic is triggered by change in A) change in temperature of ink surface or ink carrying surface or surrounding of printed area by application of heat directly or indirectly. B) Change in light source (illuminant) for keeping printed item i.e. change in visible or invisible spectral wavelength of falling light which affects appearance and observation of printed area. C) Change in atmospheric conditions of inked image i.e. direct or indirect contact of ink surface with different liquids or gases present in surrounding of inked image.

2. Energy Reactance^[3,6,7,9]

Set Reactance observed because of change in temperature is achieved because of heat reacting chemical compositions known as 'Thermochromic materials' n they have wide temperature sensitivity ranges from -400c to 2400c. At a time of ink manufacturing these materials are added in ink composition. The amount of adding is controlled and it depends on a) End use of printed product b) Colour of ink pigment and colour and colour of ink solvent c) Temperature range required for observation of reacting characteristic of ink. These factors affects the use of Thermochromic ingredients as whether ink going to be print on commercial or legal document where it plays an important role for authentication and that ink should remain on document for lifetime. E.g. 1) Patch printed of Degree certificate with Black ink at bottom and it hides classified alphabetic or numeric code. When patch is rubbed by fingertip because of heat generation it disappears and classified code get appeared which proves authenticity of document at a moment. Its application of Black Thermochromic ink with high color strength and reactive to temperature range of 400c- 600c.2) Labels printed for food packaging or bakery products where it indicates product condition i.e. whether baked product is in HOT condition or not. On a cardboard box of cheese pizza or on a metal can of chicken soup, a Red color patch or circle hiding word HOT/ COOKED. When pizza is in HOT condition because of internal heat of box patch disappears showing word HOT or when Can heated in oven circle disappears showing word COOKED. It is application Red Thermochromic ink available for printing on absorbent and non-absorbent surface and having temperature sensitivity range from 800c - 2600c. Thermochromic materials added in ink may have organic or inorganic source. The organic materials are rarely used ink large scale commercial production because of critical control on parameters and they are expensive. Inorganic materials are used on large scale. It is easy to control their properties and have no of option according requirements. Inorganic materials are also available in wide range of color and sensitivity range for temperature. Thermochromic reactance achieved in ink it maybe reversible or irreversible on printed area. It depends on the material and temperature range applied on ink because temperature range applied beyond its range may cause irreversible destructive changes.

Reactance occurred in inks is because of absorption of energy particles by ink i.e. heat energy in Thermochromic ink and photon energy by light in Photochromic ink. Light emission from light source is nothing but emission of photon particles having specific wavelength. The complete light spectrum have known range from 10-16 to 108 nanometers with max. frequency up to 1024 Hz and in this large spectrum we have ranges as Ultraviolet rays, X rays and Gamma rays below visible spectrum and above visible spectrum we have Infrared ways, Microwaves, and then radio waves. Light falling on object always give some effect on printed area, color fading is long term effect observed in day-to-day life. Different wavelengths of lights gives different effects on photochromic material, UV photo initiator and on fluorescent materials. Photochromic ink has light sensitive materials of organic or inorganic group having base of minerals, alkyl slats, compounds of benzene and phenol groups. Photochromic ink has reactance to light wavelength with effect as color to colorless or opposite or change in color. Depending on the ink application the ink composition may varies but photochromic additive used in ink should be compatible for solvent as well as application area. The color changing reactance of photochromic ink used of gift articles, fancy clothing and on scientific equipment, pharmaceutical, tablets which indicating marks or direction for consumption of product. The color changing reaction on exposure to light in photochromic ink and in metamer ink are performed on different principle. Photochromic material absorbs photon energy and changes its color but in metamer ink by exposure to light gives different color. This change in color is observed because of change in reflecting light by ink surface in normal illuminant and in observing illuminant. Instead of having photochromic additives, in metamer ink light filters are added in ink composition which filtered or blocks falling light and reflect remaining light which appears as different from falling light. This gives observation as change in color of printed image area under particular light source. Besides use of photochromic ink on glossary products, metamer ink is used on security document as a check point of authentication.

Absorption of light energy or reactance to light exposure also observed in fluorescent material and compositions having photoinitiator. Fluorescent or glow in dark material are composition of minerals, heavy metals and slats which are light absorbent in nature end emits low intensity light. Photoinitiator used in different compositions, UV glow ink, UV curable ink. The medicine having vitamins or minerals, alkali salts tends to have photo degradation when they are expose to sunlight that's why amber or dark brown bottles are used. On other hand reaction of photoinitiator with UV light is utilized in ink manufacturing, plastic manufacturing and in fabric industry. In ink manufacturing for the purpose of document security different UV contents are added. These contains have glow or change in color when they are exposed to UV light. These inks can be solvent base or polymer base which needs UV curing. These ink can have initial color or can be applied as clear coat on image, on exposure to UV light they glow, glow with different color or change to different color with glow. On Indian currency we have serial no printed on right top have UV glow and same no. at left top visible only under UV light with bright green glow.

In case of UV curing inks, photoinitiator serves to trigger polymerization process. Because of polymerization UV ink molecules state is changed at it adheres to substrate. According to end requirement of composition and end requirement of printed product on substrate, type of photoinitiator and polymerization process can be controlled. UV curing process gives us wide range of application in document security sector. UV ink having emboss effect give raised image or number in document without any physical impact and it serve a main identity mark for blind person. In current stream using UV curried polymer inks which gives raised printed image area, used for Book printing for visually challenged persons. Reactance of photoinitiator to UV light content in sunlight serves in cosmetic and pharmaceutical industry. There are labels or package having printed image which reacts with sunlight (UV exposure) and gives visual indication about self-life, expiry date and product condition in package. The medicine having vitamins or minerals tends to have photo degradation when they are expose to sunlight that's why amber or dark brown bottles are used. Such medicines have label SAFE or CONSUME printed in packet and when it gets disappeared it is cleared informed to customer.

3. Atmospheric Reactance^[4,5,6,8]

The reactance in ink because of ink additives in basic composition with respect to change in energy states as change in Temperature and Light is fast reactive in some cases with compared to change in atmosphere. Change in atmospheric condition means direct or indirect contact of printed image area with external physical or chemical component. These reaction serves as proof, legal evidence or indicator in inspection process of valuable documents. For document security fugitive inks having property to react with different chemicals and it is known as chemical reactant ink. Fugitive ink has alcoholic or aqueous base and soluble pigments in ink composition. Fugitive ink is used to print continuous background of document with uniform patterns, if it comes in contact with water or any solution, printed patterns get wash out from surface of substrate. It is clear indication to inspector for attempt of correction or counterfeiting in document. In packaging sector, fresh vegetable or fruits are packed in plastic bags. To keep them farm fresh bags are vacuum packed. But in packed bags vegetables emits water vapor and it increase internal temp of bag. If amount of vapor doesn't get controlled, it accelerates the spoiling process. To indicate freshness label printed on porous substrate with fugitive ink applied on punched window on plastic bag. The water vapor gets absorb in substrate and it reacts with ink and give indication about freshness or time when bag is packed. To preserve food products, they are packed with packaging systems as Controlled Atmospheric (CAP) and Modified Atmospheric packaging system (MAP). In packing of fruits they are packed in vacuumed bags or in sealed containers where all atmospheric gases are removed from pack. In case of bakery or fried edibles to preserve freshness and extend shelf life, it is packed with nitrogen gas in absence of oxygen in pack.

In case of fruits even in packed condition ripening process of continues fruits. During ripening process, it emits water vapor, carbon dioxide, ethylene gas and because of degradation of fruit sugar alcoholic juices are produced in fruit. The presence of ethylene gas accelerates process of ripening in pack. To slow down ripening process ink having absorption properties to gases is used to coat internal walls of pack. To indicate riping stage of fruits the labels printed with pH indicating chemicals added in ink composition. It gives color indications of ripening stage of fruits. Meat or poultry items packed in vacuum packs by complete removal of Oxygen to avoid spoiling of meat and to extend shelf life. To indicate presence of oxygen in package the indicating labels is printed from inside which have ink composition contains nanoparticles which are oxygen sensitive. This label turns visible when pack is opened. Oxygen reacting or pH indicating ink have are used in pharmaceutical and cosmetic industry also. Kits available for ovulation test and Pregnancy test are nothing but pH indicating devices showing hormonal changes.

For meat or poultry products even they are seal packed and packed in vacuum containers, they have very short shelf life and very son get spoiled. The degradation of meat items is slow and it is not possible to judge it by visual inspection in packed condition. To avoid purchasing and consumption of spoiled pack, it has indicating label. The ink printed on label have silver particles additive and it reacts with Hydrogen sulphite which get produced while decomposition process of meat. The reaction of silver particles with hydrogen sulphite change the colour of inked image as Brown to White or Black to White. It's a clear indicator of degradation of meat as hydrogen sulphite is produced when organic tissues get decomposed. Use of metals in ink as additive are also used for document security purpose, in MICR inks and in Conductive inks iron particles are added. When inked image area kept in magnetic field it generates a magnetic pulse, measured in micro Ohms ($\mu\Omega$) and according to amplitude of pulse printed character or image area is recognized at a time of inspection. But to inspect MICR or Conductive ink scientific equipment are required.

4. Conclusion

Equalize the application of inks in Document security, currency authentication, utilization and consumption of food, bakery, poultry, pharmaceutical and cosmetic sector, having energy reactance or atmospheric reactance, interacts with observer on intellectual level. The reactance considered as thoughtful reaction having scientific explanation, significant value on commercial ground and legal evidence in all forensic investigations.

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