Impact of Re-steel and RCS Textiles on Color Constituency in Printing Processes

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Abstract: *This comprehensive study analyzes the influence of re-steel and RCS textiles on color consistency within the realm of sustainable printing, specifically focusing on Avira and Iconiq brands under XD Connects organization. Employing methodologies encompassing color absorbance analysis, ink compatibility testing on laser, CMYK inkjet printers, and heat presses, this research provides an exploration of color absorbance and printing efficacy. The primary emphasis lies on understanding the unique interplay between these eco-friendly textiles and color representation, offering a novel perspective on their integration into sustainable printing processes.*

Keywords: *color absorbance, ink compatibility plasma, blocker, laser printers, inkjet printers, heat presses printers*

1 INTRODUCTION

The printing industry stands at a pivotal juncture where sustainability has emerged as a core tenet driving innovation and evolution. As the sector continues to align with eco-conscious practices, the integration of sustainable materials becomes imperative. Within this context, Avira and Iconiq, prominent brands under XDconnects, stand as trailblazers in advocating sustainable solutions. Central to this paradigm shift are re-steel and RCS textiles, representing a transformative stride towards eco-friendly substrates in the printing domain.

Re-steel, characterized by its recycled steel composition, and RCS (Recycled Cotton and Synthetic blend) textiles, crafted from reclaimed cotton and synthetic fibers, symbolize the vanguard of sustainable material innovation. These materials embody not only environmental responsibility but also a commitment to superior quality and functionality.

The burgeoning interest in these materials lies in their promise to revolutionize color representation and consistency in printing processes. Through their unique properties and composition, they offer an unparalleled opportunity to reshape conventional practices, redefining the very essence of color fidelity and vibrancy in print outputs.

This study seeks to unravel the intricate relationship between re-steel, RCS textiles, and color consistency within the context of Avira and Iconiq brands [6] from XD Connects. By scrutinizing their impact on color absorbance, ink compatibility across laser, CMYK inkjet, and heat press printers, this research endeavors to provide a comprehensive understanding of the transformative potential these materials hold for sustainable printing practices.

Furthermore, this introduction sets the stage for a thorough exploration of how these materials, embedded within the ethos of Avira and Iconiq brands, are poised to redefine the printing landscape, offering a blend of sustainability, functionality, and aesthetic excellence.

1.1 Factors that influence the colors in printing process

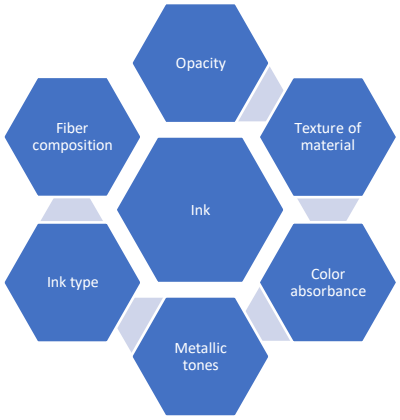

Fig.1 Factors that influence the colors in printing process

2 COLOR ABSORBANCE

The Beer-Lambert-Bouguer Law [1] outlines the connection between the absorption of incoming light and materials that absorb it. According to Beer's Law, the concentration of a solution is directly related to its absorption of light for a given path length. Put simply, this law identifies and measures which substances can absorb or allow radiant light to pass through them.

When light enters a material, its power diminishes because the intensity of the light exiting the material is lower than the intensity upon entry. This reduction or decrease in light radiation is explained in terms of Reflection (Scattering), Absorption, and Transmittance. Transmittance refers to the portion of incoming light that emerges from the material, while absorbance quantifies the light absorbed by it. Reflected or scattered light typically constitutes a minimal fraction of the incoming light and is often disregarded. Consequently, 100% transmittance denotes no light absorption, whereas 0% transmittance signifies the complete absorption of incident light by the material.

The Beer-Lamber Law is expressed mathematically by the following equation:

$$A = \varepsilon \cdot b \cdot c \qquad (1)$$

where

- A is absorbance, which is the measure of light absorbed by the substance. Absorbance does not have units.
- ε is the molar absorptivity, also called the extinction coefficient, which is an intrinsic property of the substance. Molar absorptivity is represented with units of L mol-1 cm-1.
- b is the path length of the sample and is usually expressed in cm. Path length, also known as optical path length, denotes the distance traveled by light through the substance or sample being measured. Any change in the path length or thickness of the substance would modify the absorbance value.
- c is the concentration of the sample or analyte whose absorbance is being measured using Beer-Lambert's equation. Concentration is defined as the amount of solute in the total volume of solution. The concentration of any solution can be expressed in mol L-1.

2.1 Obtaining an Absorbance Spectrum

The majority of the light visible to us, such as sunlight, is considered white light. White light is composed primarily of seven colors, each exhibiting a different hue at various wavelengths. We perceive distinct individual colors corresponding to each of these wavelengths.

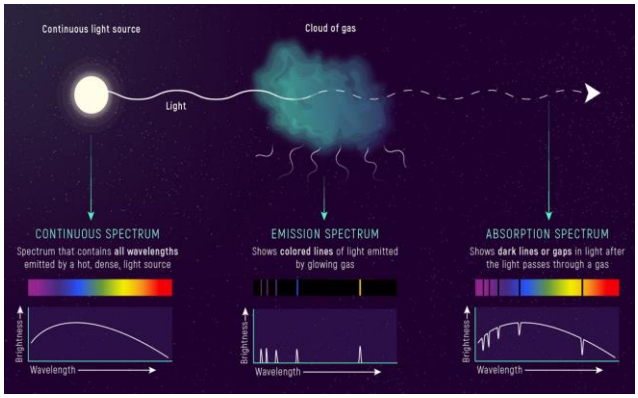

Fig.3. Absorption Spectrum

We've looked at what light does all at once, but for many things, including this experiment, the light is broken down into wavelengths. Each wavelength has its own color. When we see how each wavelength of light interacts with the solution on its own, we can generate an absorbance spectrum (graph) for your solution.

Every wavelength possesses distinct absorption capabilities [2], and here's an illustration of how this occurs:

1). Various colors of light sequentially reach the solution.

2). Each color interacts with the solution's molecules, resulting in partial Absorption of some light while the remainder is Transmitted.

3). The quantity of light transmitted varies for each wavelength.

4). The transmitted light travels through the solution to the detector.

5). The machine then converts the transmitted light amount into the blocked or absorbed light quantity by the solution.

Once the light engages with the solution, a graphical representation, akin to the Chlorophyll A spectrum, can be generated.

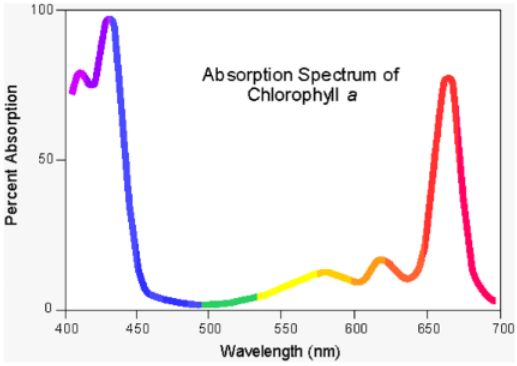

Fig.2. Wavelengths depending on color

3 INK COMPATIBILITY

Various inks were tested for adhesion and color retention on re-steel and RCS textiles using experimental testing's on as more possible products. Adhesion scores and colorimetric values were recorded, providing a quantitative measure of ink compatibility.

Also ink compatibility depends also on the type of machine of printing and also on technique used for printing.

For the re-steel material we did tests on below types of printers [3]:

- Laser Printers
- Inkjet Printers
- Heat Presses Printers

3.1 Laser printers

Laser printers rely on toner to create the image on any printed page. Polymers, organic compounds, and a variety of minerals tend to be the key components of printer toner.

For the Laser printers we didn't face some problems with re-steel products, we've used the similar parameters for printing as for the rest of engraving.

The parameters used for Engraving was Power: 50, Speed: 400, Distance between lines: 0.6

Products used:

- Coppa RCS re-steel vacuum tumbler with lanyard
- RCS Re-steel cork small vacuum coffee mug
- RCS Re-steel easy lock vacuum flask
- Eureka RCS certified re-steel single wall water bottle
- Soda RCS certified re-steel carbonated drinking bottle
- Avira Avior RCS Re-steel bottle 500 ML
- Avira Avior RCS Re-steel bottle 1L
- Avira Alya RCS Re-steel tumbler 300ML
- Avira Ain RCS Re-steel 150ML mini travel bottle
- Avira Alcor RCS Re-steel single wall water bottle 600 ML

3.2 Inkjet printers

CMYK inkjet printers excel in printing on RCS materials because of their versatility in handling various substrates. RCS items, often coated with resin, demand inks that can stick effectively and generate precise, detailed prints. Tailored for inkjet printing, CMYK inks are specifically engineered to fuse well with coated surfaces, ensuring superb adhesion and print quality.

The CMYK color model, utilizing cyan, magenta, yellow, and black inks, offers a wide range of accurate color reproduction. This capability enables inkjet printers to deliver vibrant and true-to-life prints on RCS materials, preserving color accuracy and sharpness for diverse printing needs.

To assess how RCS material affects ink, we conducted printing tests on 25 RCS items made of steel or re-steel. Across all items, the ink did not adhere properly, indicating an adhesion issue.

To achieve high-quality printing, a pretreatment involving Plasma [4] was implemented before printing on the products. Plasma treatment activates the surface of RCS materials by altering their surface energy and chemistry, making them more conducive to ink adhesion. This process increases surface reactivity, enhancing the RCS's ability to evenly disperse ink and adhere during printing.

Plasma treatment effectively purges RCS surfaces of contaminants, organic residues, and impurities. This thorough cleaning ensures the surface is free from any elements that could hinder ink adhesion or affect print quality.

The activated surface resulting from plasma treatment significantly enhances ink bonding and adhesion to RCS materials. This improvement in adhesion helps prevent issues like ink smudging, lack of color vibrancy, or uneven printing commonly observed on untreated surfaces.

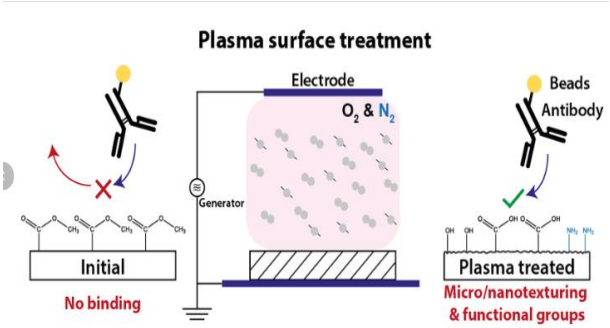

Fig.4. Plasma surface treatment process

Fig.5. Plasma surface treatment

Preparation for printing and coating using plasma has become a standard procedure across various common printing methods like digital, pad, screen, or offset printing. Plasma pre-treatment significantly enhances the adhesion of printing inks and varnishes to surfaces, leading to a remarkable improvement in print quality.

Many materials, including metals, glass, ceramics, and even natural substances like wood and textiles, often pose difficulties for printing but can be made receptive to printing through plasma functionalization. Plasma pre-treatment enables successful printing and coating on numerous polymers that typically have "non-stick" surfaces.

The image below demonstrates the interplay among surface energy, printing ink, and plasma. In the upper image, a droplet of ink is applied to a surface, followed by the resulting print below. The initial droplet exhibits a large contact angle exceeding 90°, resulting in poor surface wetting, causing ink contraction and uneven wetting. The two drops in the middle display a flatter contact angle, thereby improving the printing outcome.

The most favorable outcome occurs when the contact angle is 0°, allowing ink droplets to wet the surface uniformly, creating an even print image.

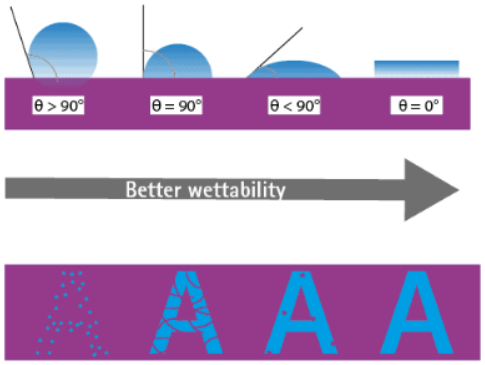

Fig.6. Interaction surface energy of printing ink and plasma

3.3 Heat presses printers

Heat-set printers are a type of printing technology that employs high-temperature drying processes to set inks on surfaces. When it comes to printing on RCS (Resin-Coated Substrates) materials, the impact of heat-set printing depends on various factors.

The high-temperature drying process in heat-set printing contributes to faster ink drying, which can result in sharper, more defined prints on RCS substrates. It helps prevent smudging or smearing, resulting in high-resolution and vibrant prints.

We test the printing on 30 RCS textile products with a plastisol ink and the result was for 90% with ghosts in printing caused by material and by absorbance of the color.

In below images (Fig.7) you can see the ghosts in printing.

Fig.7. . Ghosts in printing

In order to solve this issue with ghosts in textiles RCS printing we use blocker [5] in printing.

In textile printing on RCS (Resin-Coated Substrates), a blocker or blocking agent is often used as a crucial part of the printing process. This blocker serves various purposes to ensure high-quality, precise prints on these specialized substrates:

Ink Control:

Blockers are used to control the spread and absorption of ink on RCS textiles. They help prevent excessive ink penetration into the substrate, ensuring that the ink remains on the surface and doesn't bleed or feather, which could affect print quality.

Edge Definition:

By containing the ink within the desired printing area, blockers contribute to sharper and well-defined edges of printed designs or patterns on RCS textiles. This is particularly important for achieving intricate or detailed prints without blurring or smudging.

Color Intensity and Vibrancy:

Blockers assist in maintaining the vibrancy and intensity of colors by preventing them from spreading too much or being absorbed unevenly into the RCS substrate. This ensures that the printed colors appear rich and true to the intended design.

Substrate Protection:

In some cases, blockers are applied to protect the RCS substrate itself. They can act as a barrier between the substrate and the ink, preventing any adverse reactions or damage that might occur due to chemical interactions between the ink and the coating on the RCS material.

Improved Print Precision:

Utilizing blockers aids in achieving more precise and accurate prints, especially when dealing with fine details or small text. They help in controlling the ink's behavior, ensuring that the printed elements maintain their intended shape and clarity.

Customization and Adaptability:

Different blockers can be tailored to specific printing needs, such as varying ink formulations or substrate characteristics. This adaptability allows for optimized printing results on diverse RCS textiles.

Compatibility Considerations:

Choosing the right blocker is crucial to ensure compatibility with both the ink being used and the RCS substrate. Compatibility testing helps prevent any adverse effects or undesired outcomes during the printing process.

So basically, in printing the blocker is considered as a color in plus at printing.

Result of printing after adding blocker in printing:

Fig. 8. Print with blocker added

4. CONCLUSIONS

In conclusion, this study substantiates the transformative potential of re-steel and RCS textiles in redefining color consistency in sustainable printing. The recommendations stemming from this research advocate for widespread adoption and strategic implementation of these materials, signaling a pivotal moment in the evolution of the printing industry towards sustainable and vibrant outcomes.

The results of our tests on RCS for 3 types of printers indicates that the composition of RCS material force us to do a pretreatment or a posttreatment of the material, in our case for Re-steel with Plasma and for RCS Textile by adding blocker.

For the steel and textile materials that are not recycled we didn't face this issue of having issues with the quality of printing for these types of printers.

REFERENCES

[1] Beer-Lamber Law: https://www.edinst.com/blog/the-beer-lambert-law/

[2] Color absorbance: https://www.sciencebuddies.org/science-fair-projects/project-ideas/Phys_p073/physics/radiant-energy-absorption-colors

[3] Type of printers: https://www.sciencebuddies.org/science-fair-projects/project-ideas/Phys_p073/physics/radiant-energy-absorption-colors

[4] Plasma pretreatment: https://www.plasmatreat.co.uk/plasma-treatment/processes/plasma-pretreatment-printing.html

[5] Blocker in printing: https://craftatlas.co/crafts/block-printing

[6] Properties about products: https://www.xdconnects.com/

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