Section A -Research paper

Study of Printability of Bio-based Plastic in Gravure Process

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ABSTRACT:

Printability is function of different printing technical parameters which describes whether the printing on any media can be made at par with printing standards. In this modern era bio-based plastic have emerged as new alternative for replacing conventional plastic to protect Mother Earth as usages of printing plastic is very common in our day to day life. In this domain Gravure printing is known for good printability with high speed production. But compatibility of bio-based plastic with gravure printing is still a major concern. Hence to study printability aspects on bio-plastic is an attempt to make for exploration of mutual compatibility of media and printing process which will prove a boon in upcoming future by replacing conventional plastic.

Keywords: Printability, Bio-based plastics, Gravure process, Ink density, Dot Gain, Hue Error.

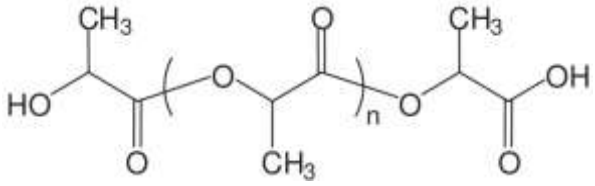
Introduction

In this era of globalization and ever-growing demand for convenience in all walks of life, polymer family offers a wide range of plastic films includes new generation environmentally friendly substrates for various printing and packaging applications.

Plastics: With the advent of plastic material and growth of industrializations leads to printing on plastic materials to cater the need of ever-growing demand of packaging especially flexible packaging. Printing on plastics was one of the most challenging jobs in last century for printers.

Need of Environmentally friendly plastics for Printing and Packaging: Plastics are not inherently bad in nature but they are bad for environment as they are not environment friendly because plastic materials are not degradable. So, there is great need arises for the development of degradable substrates/ materials for printing & packaging applications. Recently some fossil/ bio-based plastic has been reported by the researchers which can be shaped suitably for application as substrates for printing for packaging applications. Sustainability and biodegradability are the biggest strengths of bio-plastics and hence, they have been readily accepted even in applications where they are marginally or sometimes expensive than conventional plastics. Bio-plastics have an excellent potential to be used for printing & packaging applications, due to ability to their degradability.

Printing on Plastics: Printing is considered as one among greatest invention of mankind. It has touched almost every life after its invention either in form of printed product or in form for packages. There are various processes of printing, categorically divided into impact and non-impact process printing suitable for printing on different substrates for different applications. Different printing process has their own applications, advantages and limitations and is suitable for printing on different set of materials. Printing on plastics usually comes under flexible printing in which Gravure Printing Process and Flexography Printing Process are leading printing processes in this field.



Chemical Structure of PLA (Source: https://bioplasticsnews.com)

Gravure Printing Process: Gravure Printing Process is high-speed, high-quality printing process primarily used for printing on plastics for packaging applications and comes under flexible printing. Gravure process is suitable to produce consistent and very high-quality printing even on thin films and low-grade substrates. Gravure process has many advantages, but it has some operational difficulties due to special requirements on machine during printing, for substrates having tendency to elongate during printing under pressure.

Printability: Printability refers to the suitability of substrate for reproduction of good quality text, picture and pattern in single as well as in multi-color. So, Printability is the ability of substrate to take print, it is sum total of various factors affecting quality and quantity during print production. It is an important factor affecting selection of materials (Printing Substrate, Inks, Auxiliary arrangements and Special requirements) for print productions. Several factors play important role to decide printability of a substrate, which are surface characteristics like thickness, porosity, smoothness, color & whiteness and surface coating apart from that compatibility of substrate with printing process is also very important.

Various printing attributes are measured for getting objective views for printability of selected materials either for selection or to determination for print production. There are various print properties elements are available for measurement and incorporation for better and specific print

production, however following are the necessary print attributes which should be followed for determination of Solid Ink Density (SID), Dot Gain and Hue error.

Research Objective

The key objective of the study is to analyses printability of bio-based plastic gravure printing process.

Materials and Methodology

To study and analysis of printability of bio-based plastics on Gravure process following steps are followed:

i. Preparation of Test Chart: Suitable test chart was prepared by incorporating various elements to check printability, run-ability and readability of printed samples.
ii. Printing Processes: Gravure printing process was selected for this study under standard press room condition.
iii. Machine: Printing on Gravure proofing machine was done for selected substrate.
iv. Selection of Substrate: Selection of substrate was limited to PLA (Bio- based) for this study.
v. Selection of Printing Inks: Solvent based Gravure printing ink was used for this study.
vi. Colorimetric Measuring instrument: X-rite, Exact spectrophotometer was used for capturing of data.
vii. Gravure Cylinder Preparation: Gravure cylinder was prepared using Laser engraving on HelioKlischograph smart K5.

Selected substrate PLA (Bio-Based) was printed on gravure proof machine with suitable process inks in standard press room conditions maintaining all printing parameters. Prints were selected for study on equal region to check the consistency and accuracy of printing parameters for checking printability.

Data Analysis

To study printability aspects of bio-based plastic using gravure process numerous printing parameters were taken into consideration. These are as follow:

i. **Ink Density:** Ink density value (Avg. Value) for all process color i.e. Cyan, Magenta, Yellow and Black is presented in figure 1. During observation it was found that cyan color demonstrated minimum ink density value while black color demonstrated highest ink density value followed by yellow color.

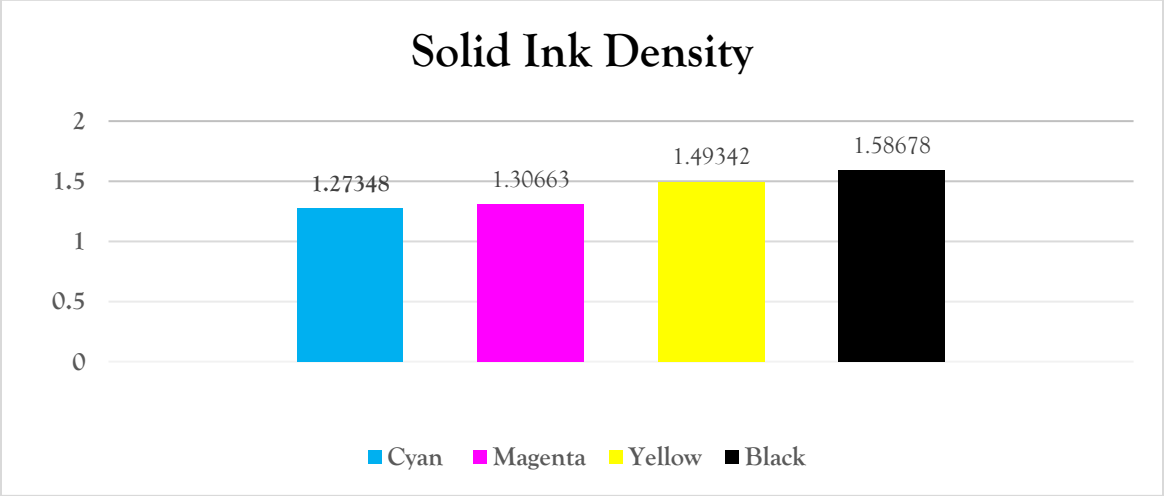


Figure 1: Average Ink density value of process color on PLA (Bio-based Plastic)

ii. **Dot Gain:** Value of dot gain for process color at different level i.e. 75%, 50% and 25% on bio-plastic i.e. PLA using gravure process is shown in figure 2, 3 and 4 as below.

a. **Dot Gain at 75%:** It was observed that magenta color demonstrated highest dot gain followed by black color on selected substrate, while lowest dot gain was observed for cyan color.

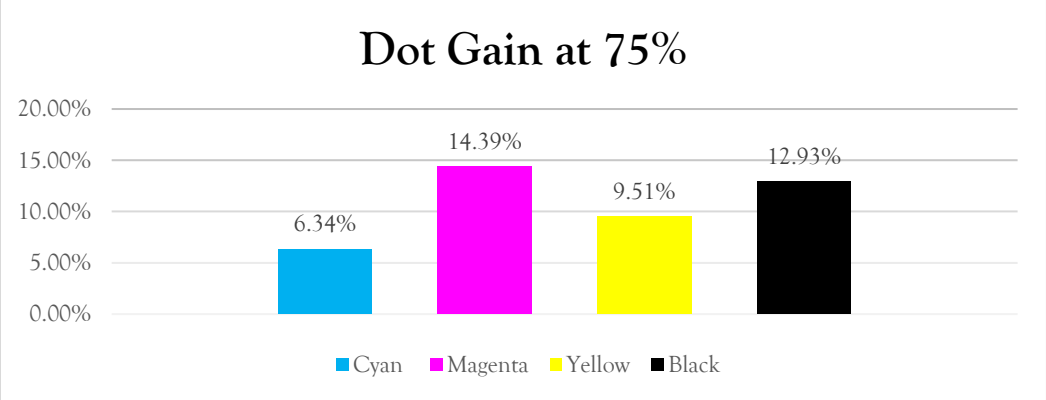


Figure 2: Dot Gain (Average value) at 75% on PLA (Bio-based Plastic)

b. **Dot Gain at 50%:** In case of 50% dot gain, it was observed that on magenta color demonstrated highest dot gain followed by black color, while yellow color exhibited lowest dot gain on PLA bio-based plastic.

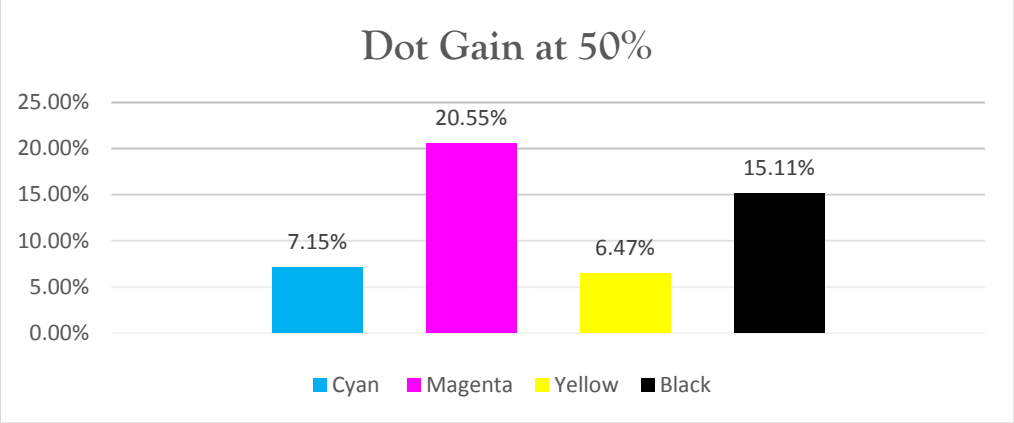


Figure 3: Dot Gain (Average value) at 50% on PLA (Bio-based Plastic)

c. **Dot Gain at 25%:** While observing dot gain at 25%, it was observed that magenta color demonstrated highest dot gain followed by black color, cyan color dot gain was lowest on PLA bio-based plastic.

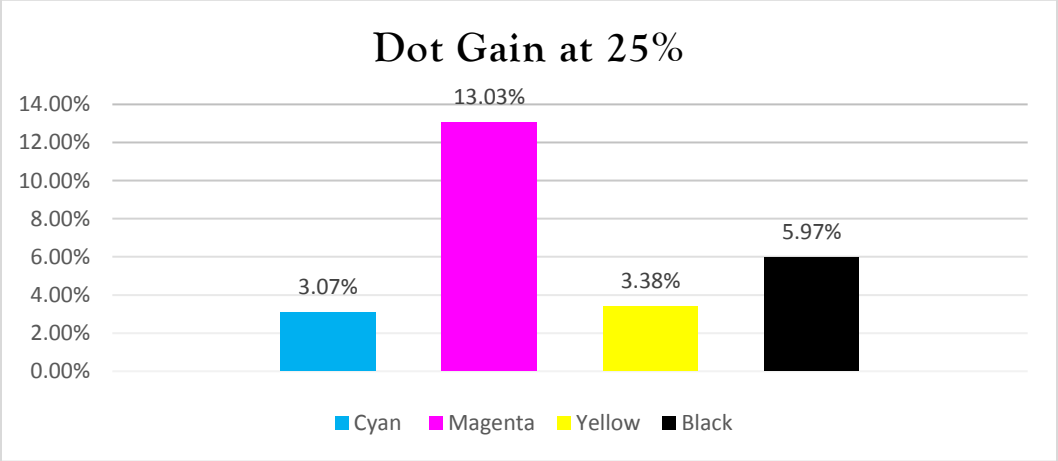


Figure 4: Dot Gain (Average value) at 25% color on PLA (Bio-based Plastic)

iii. **Hue Error:** The average hue error for all process color i.e. Cyan, Magenta, Yellow and Black is depicted in figure 5. It was found that yellow color exhibited minimum hue error value while black color exhibited highest hue error followed by magenta color.

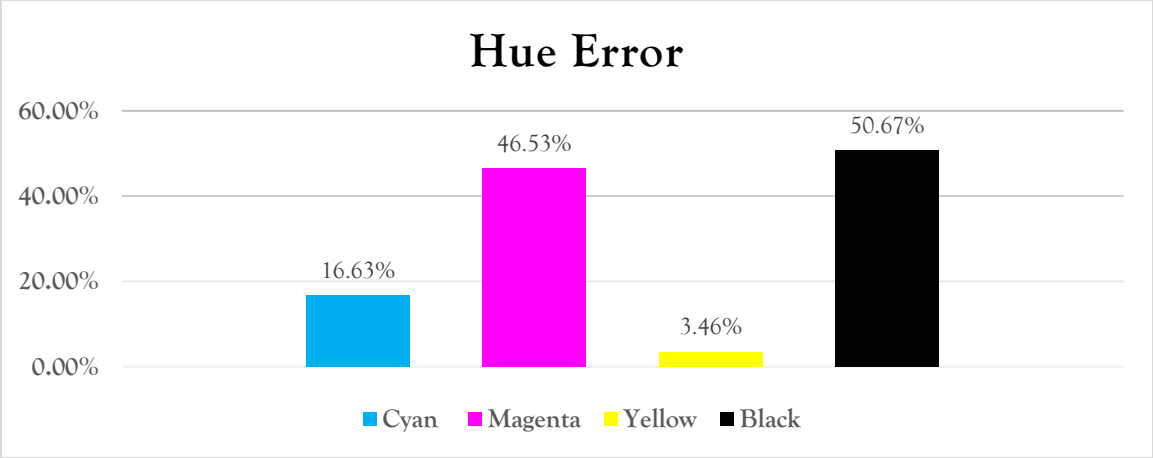


Figure 5: Average Hue Error of process color on PLA (Bio-Plastic)

Results and Discussion

In order to study printability aspects on bio-based plastic using gravure process numerous parameters were taken into consideration. Collected information while study for various printing parameters is summarized as below:

Printing Parameter		Cyan		Magenta		Yellow		Black	
		Mini.	*Max.*	*Mini.*	*Max.*	*Mini.*	*Max.*	*Mini.*	*Max.*
Solid Ink Density		1.2482	1.2998	1.2778	1.3346	1.4816	1.5155	1.5694	1.6098
Dot Gain	At 75%	5.20%	6.80%	13.20%	18.50%	7.20%	17.10%	11%	25%
	At 50%	5.60%	8.70%	20.00%	21.30%	3.80%	12.10%	11.00%	36.50%
	At 25%	1.90%	4.80%	11.80%	15.10%	2.00%	8.10%	2.80%	9.10%
Hue Error		16.50%	16.70%	46.30%	46.90%	3.40%	3.50%	49.10%	53.70%

Table 1: Printability parameters on bio-based (PLA) using Gravure Process

Conclusion

Analysis of data reflects that most of the printing parameters are very close to standard value. It was observed that Solid Ink Density (SID) of all process color were in the range even PLA (Bio-based) has acceptability of higher ink density which in turn leads to better ink density and colorimetric values. Dot gain was measured at 75%, 50% and 25% for all process color, it is found that dot gain was in acceptable range of 5 to 15 percent for printing along with solid ink density and other printing parameters. Hue error was also observed in range for Cyan and Yellow.

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