Fuser Roll Material Effects on Digital Print Quality

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Abstract

Fuser roll materials play a dominant role on digital print quality. The type of fuser roll coating, thickness of the coating, surface finish (texture), filler materials, back-up pressure roll material, shore A durometer of the rubber and printer speed are some of the factors which influence the final output print quality. Silicone rubber rollers by virtue of their compliancy produce an acceptable print quality, matt finish images and good fuse grade. These rolls are often registering a poor roll life. Hard fuser rolls with a fluoropolymer coating does accomplish a good roll life, but often produces a poor mottled print (images). A hybrid roller which will capture the good attributes of the hard and soft rollers seems to be the ideal choice to accomplish the exceptional print quality and fuse grade requirements of digital printing.

An overview of fuser roll materials and their impact on digital printing will be discussed. The new hybrid roller is still evolutionary and its long- range implications need to be studied, one and may be the way of the future with the advent of higher speed printing as well as higher resolution of printing.

Introduction

Digital printing demands an exceptionally high print quality and fuse grade. The basic requirements of print quality depend on the consistency from page to page especially in a book publishing application. The output should be free of high gloss, have uniform optical density, mottle free solid area (logo and images), excellent fuse grade coupled with a low degree of smear. Any deviation from the print quality requirement usually results in unacceptable print output along with poor customer satisfaction.

Compliant silicone rubber based fuser rollers produce an excellent matt finished print quality along with good fusing. However, these rollers often lack a good roll life. The failure mode leaves a wear step, which shows, on the printed sheet when customers use different width papers during their print run. This also makes it prohibitive to service the printer, as well as, results in poor customer satisfaction due to frequent service interventions.

Rollers with a fluoropolymer coating (hard) generally exhibit a good roll life, but invariably results in a mottled print, especially with images and large solid areas. These rollers will perform acceptable for line printing. However, the smear resistance will be poor with the printed samples.

The hybrid roller employs the good attributes of both the hard and soft rollers. This combination will produce acceptable print and fuse quality of the print output, as well as, generate better roll life. The coating thickness was maintained within the printer design constraints. The surface texture was maintained in between an extremely smooth and very rough texture. Two levels of rubber shore A durometer were experimented with to study the degree of compliancy and its impact on print quality.

This paper will address the print quality and fuse roll material interactions in a typical electro-photographic digital printing process.

Experimental

Four (4) new fuser rollers were evaluated in typical high-speed electro-photographic printers (both LED and Laser). The test was performed in a 600 dpi configuration using a polyester toner. The pressure roller was kept the same type for all the four (4) test rollers. The test was performed for about 50,000 print cycles for each test roller. The paper used was a typical 20-pound bond paper. The roller description was as follows:

- Fluoropolymer coated hard roller (1)
- Compliant silicone rubber roller (2)
- Low durometer rubber hybrid roller (3)
- High durometer rubber hybrid roller (4)

The print samples were collected with all the test rollers. The samples were analyzed and rated by a team of people. The empirical type of test data were not generated as the test methodology had large variations from laboratory to laboratory. The results were tabulated. For test data, refer to table 1.

Table 1. (Print Quality Test Data)

Roll No.	Print Quality	Fusing	Mottle	OD Unif.	Smear	Gloss
1.	Accept.	Margin.	Poor	Poor	Poor	High
2.	Good	Good	Good	Good	Good	Lowest
3.	Good	Good	Good	Good	Good	Low
4.	Good	Good	Good	Good	Fair	Slight

Results and Discussions

The fluoropolymer coated roll (1) showed few performance issues. The hard surface of the roll does not have intimate contact with the paper surface, which had its own peaks and valleys. This resulted in all the peaks fuse better than the valleys. This phenomenon explains the observations made on the print quality test data. In addition, this hard roller necessaties the use of very smooth paper to obtain acceptable print and fuse quality.

The compliant silicone rubber roller (2) produced a good matt finished print quality. The fuse grade and smear resistance of the print samples were excellent. The roller is in intimate contact with the paper surface. This helps to accomplish better fusing with the peaks and valleys of the paper surface. The main issue with this roller was the wear step created by the paper. If grooves are cut into this roller, this will show in the print output. This will prevent one from using multi-width papers.

The test data associated with roller 3 and 4 shows the performance seems to meet the requirements of digital printing. The roller exhibits the attributes of the compliant roller in terms of fusing. However, a life data test needs to be generated with these rollers. The conceptual idea of hybrid rollers seems to pass the preliminary data testing. The compliancy of the rubber was still maintained, along with a wear resistant thin layer, might produce the necessary life. If this is the case after further testing, one can utilize the roller for digital printing process.

Conclusions

The digital printing process does require a higher print - quality; good fuse grade, lower smear resistance, lower gloss, uniform optical density, less mottling and wider media latitude. The hard roller provides the roll life with some performance issues. The compliant silicone rubber roller provides the performance needs, but may exhibit the roll life issues. The hybrid roller fills in the voids left by both the hard and soft rollers. In order to accomplish this, one needs to balance the properties of the printer components judiciously to ensure acceptable customer satisfaction. This study addresses one facet of the printer material, namely fuser roller material. This study may also offer few more choices for the printer sub-system design engineers in a typical high speed 600 dpi printing process for digital application.

Biography

Velliyur Sankaran has worked on electrophotography for over 30 years. He has worked for IBM and Oce Printing Systems USA, Inc. Presently, he has formed his own consulting company. He has published numerous papers and has 5 patents issued to him. He has a M.S. in Chemical Engineering and Polymer Science.

James C. Smith has a B.S. in Pulp & Paper Science Technology and a B.A. in Chemistry. He is currently employed with Oce Printing Systems USA, Inc. His work is primarily focused on evaluating substrates for printability and runnability through laser printers, analyzing different consumables and supporting engineers, sales and marketing for printer and media related issues.