Océ's Direct Imaging 7 Color Print Technology

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Abstract

Océ's Direct Imaging (DI) technology is a unique 7 color dry-toner based print process.[1,2] The technology has been applied since 2001 in Océ's CPS700/800/900 color copiers/printers. The technology is unique in the sense that digital information is directly converted into a toner image in a one-step process. This makes it a true digital printing process.

This paper gives an overview of Océ's DI technology. Major strengths will be discussed as well as the main underlying technological innovations.

Introduction

Océ has already distinguished itself in black & white copying/printing technology with unique characteristics:

1. Use of mono-component, conductive and magnetizable toner.
2. 'Adhesive' contact transfer of toner to a rubber intermediate without use of electrical forces.
3. Océ Copy Press technology: single step transfer and fusing of toner from rubber to paper without use of silicon oil (similar to offset).

Use of mono-component conductive toner has resulted in very stable and robust development processes (inductive charging instead of tribo-charging, virtually speed independent, uniformity). Contact-transfer results in very high print quality and no ozone production (no electrical transfer). Océ Copy Press technology gives a very robust transfer of toner to paper and a high level of media flexibility (especially surface texture).

In the transition from B/W to color printing, we decided to develop a color printing process based on the same characteristics as our proven B/W technology, thereby maintaining beforementioned proven strengths.

Direct Imaging: basics

In Direct Imaging, we use 7 DI-drums to build a 7 color toner image. About 7500 conducting tracks on the surface of each DI-drum are controlled by means of specially designed ASIC's that convert a digital image into a voltage pattern.[2] When any given track is powered with 40V, mono-component toner which is both conductive and magnetizable, is locally adhered to the surface of the DI-drum in a single step process (see figure 1). This disinguishes DI from electrophotographic processes where a toner image is formed on a photoconductor in several successive steps (charging, exposure, developing, etc).

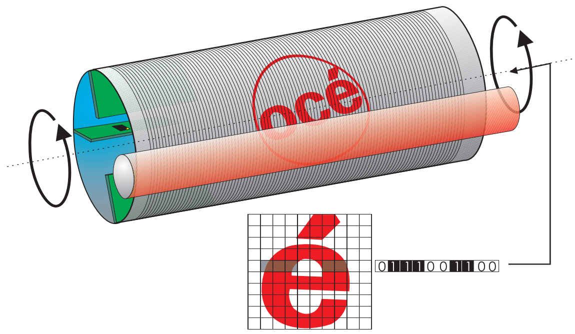

Figure 1. Direct conversion of digital data into toner-image. Schematically shown is a DI-drum with conductive tracks and a toner development roller.

The DI drum has a SiO_x top-layer of about 1 micron thickness. An applied electric field across this top-layer attracts inductively charged tonerparticles to the drum tracks. A key component is the developing roller with a very localized, very strong, high-gradient magnetic field. This so-called 'magnetic knife' attracts toner along a line perpendicular to the rotational direction of the drum and the track pattern. A thin metal sleeve rotates around this stationary magnetic knife. With zero voltage on the drum tracks the large magnetic force of the development roller cleans all toner from the drum. When an image is to be printed, drum tracks are switched to 40V and resulting electrical forces will locally cause toner particles to be printed. The number of drum tracks determines the axial print resolution (currently 600dpi). The switching frequency of drum-tracks determines the tangential resolution. This gives a high degree of freedom in choosing the resolution in the tangential direction. In the CPS800/900 (figure 2) this is fixed to 2400 dpi, but this can in principle be much higher.

Figure 2. CPS900 digital press.

All 7 DI drums produce a separate color image (black, blue, red, green, cyan, magenta and yellow). On each drum a mono-layer of toner is developed. A soft silicone rubber intermediate roller collects all 7 color images and fuses the full color image on paper in a single pass process with high color registration accuracy (see figure 3). The resulting full-color image is a composition of several mono-layers of color pixels positioned side by side instead of color overlays. This results in low toner usage, low differential gloss and an offset look and feel.

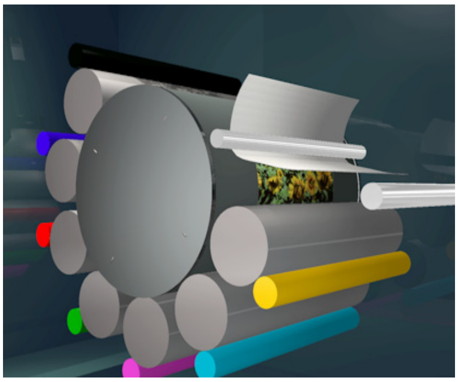

Figure 3. Schematic representation of total DI-print process illustrating the Color Copy Press principle

Challenges and Innovations

Of the many challenges and innovations in the development of Direct Imaging, three will be briefly described in this section: toner, DI-drum and Océ's Color Copy Press.

Transparent, Conductive and Magnetic Color Toner

For our black toners we use iron-oxide as a magnetic pigment and a carbon black coating for electrical conductivity. Applying one or both of the above would result in color toners with only one color: black.

Electrical Conductivity

For electrical conductivity we apply a transparant conductive tinoxide coating on polyester based color toner particles. This results in good conductivity and transparancy. A very good stability of the coating is realized by a sophisticated coating technology.

Magnetization

Because of the required color and magnetization of toner particles, we could not use conventional ironoxide pigments because of too low magnetization and large specific surface area (small particles, typ. 0.2 micron). We found that pure iron proved to be a good alternative. Iron has a 5 times higher saturation magnetization and a much smaller specific surface area (larger particles, typ. 1.5 micron), enabling a significant reduction of the required amount of magnetic pigment and light absorption.

Color Gamut

To maintain a sufficiently large color gamut, we needed to minimize the required amount of magnetic pigment. Therefore we developed magnetic rollers with very high magnetic force fields. We reached magnetic flux densities in the developing nip exceeding 2 T with very high field gradients.

To further improve color gamut, we added fluorescent colorants in some of our toners to compensate for the loss of reflection due to the remaining amount of iron pigment particles.

DI-Drum: Towards a True Digital Printing Process

In a true digital printing process one would want to convert digital data directly into a toner image. Although electrophotography is the mainstream digital printing technology, it can not be considered a 'true' digital printing technology. Process steps like charging and exposure are essentially still analog. In the DI technology, digital data is fed into a rotating drum where this data is converted to a 'pixel' pattern on the conductive drum tracks and toner is directly deposited to the adressed pixels.

Producing DI drums with conductive tracks on the surface with a high density (600 dpi) controlled by electronics from the inside of the drum proved to be no sinecure. Advanced new production technologies (micro machining, laser technology, thin film deposition) as well as smart innovative electronics (mixed signal ASICS[2]) were developed.

Océ's Color Copy Press

To be able to use Copy Press technology for DI we developed a rubber-coated transfer intermediate cylinder (see figure 3) around which the 7 DI units are placed. Accurate and stable color registration is achieved by coupling the DI drums to the intermediate with cogwheels. In the transfuse step (toner-to-paper) we need a higher temperature for toner-fusing than in the transfer step (toner-to-intermediate). Therefore, we decided to use glass as the base material of the intermediate and use a halogen heater on the inside to focus energy in the fusing nip.

Conclusion

Océ's Direct Imaging technology is a truly unique print process in the sense that digital information is directly transformed into a toner image in a single process step. Specific strengths of the technology are similar to our B/W systems: robustness, reliability, stability and high quality. In addition, toner usage is low because of this monolayer technology. Although developing Direct Imaging as a unique new printing technology was a big challenge, the anticipated strengths have been achieved and we feel the technology has great potential.

For customers, the main advantages of the technology are reflected in a very stable and consistent print quality (over time and across population of machines), high reliability and an offset look and feel of printed output.

References

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2. M. Slot, R. van der Meer, Smart Printhead Electronics controls Print Quality in Océ's Direct Imaging Process, *Proc. IS&T's NIP17 Int. Conf. on Digital Printing Technologies, Ft. Lauderdale, Florida*, pg. 690 (2001).

Biography

Marcel Slot received his M.Sc. degree in Applied Physics from Twente University of Technology in the Netherlands in 1990. Since 1990 he has worked at Océ-Technologies in Research and Development. Most of his professional career was dedicated to the development of the Direct Imaging technology, although in several different functions and projects and with varying fields of interest (a.o. magnetics, particle-dynamics, excimer-laser micro machining, thin-film coatings). At present he is department manager of Group Research and Technology at Océ's main R&D centre in Venlo.