Reimageable Offset Master - A Close Look to the DICO Process Parameters

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Abstract

The laser induced thermal transfer enables the first commercial available reimageable offset process in MAN Roland's DICOweb. Main steps of the cycle are: imaging, fixing, conditioning and de-imaging after the print run.

Two surface conditions of this closed loop are of particular importance: ready to image and ready to print. To obtain good adhesion of the image the surface has to be cleaned thoroughly. That means neither any remains of the previous image nor any other contamination should be present on the substrate. In this context we investigated the influence of the de-imaging step on the surface energy and thus the adhesion. Good lithographic properties in wet offset may be characterised by a sufficient contrast of image and background concerning ink and water reception. The DICO process comprises a special conditioning step to ensure that contrast.

An important parameter of a printing master is its run length stability. We examined the imaged print forms with a white light interferometer and developed a consistent model describing the connection of transfer parameters and achieved run length. Laser induced thermal transfer needs a well defined nip between donor ribbon and substrate. A configuration was developed in which appearing problems like dust and gas bubbling are solved in the DICO cycle.

Introduction

The DICO (Digital Change Over) technology was first shown to the public on DRUPA 95 as a concept study[1]. With the year 2000 the first product out of this development is now available, the DICOweb offset press. Unlike other CTPress systems the DICOweb operates according to the principle of image management. This philosophy means imaging, de-imaging and re-imaging in the press without the use of films or printing plates.

The trend within the graphic arts industry towards shorter run length produces a strong demand for printing technologies which allow the economical production of small circulations. Instead of only optimizing the productivity of the print run it is necessary to improve the throughput of the entire workflow. Our concept of image management is able to fulfill the demands of short run color production. The heart of this system is the DICO Cycle.

The DICO Cycle

Figure 1 gives an overview about the DICO Cycle. The right part describes the normal course of events for the change over of the image, which happens in parallel for each printing unit.

De-imaging: After the printing run has been completed the ink and thermal transfer material are removed from the cylinder using a special erasing solution and a cleaning fleece.

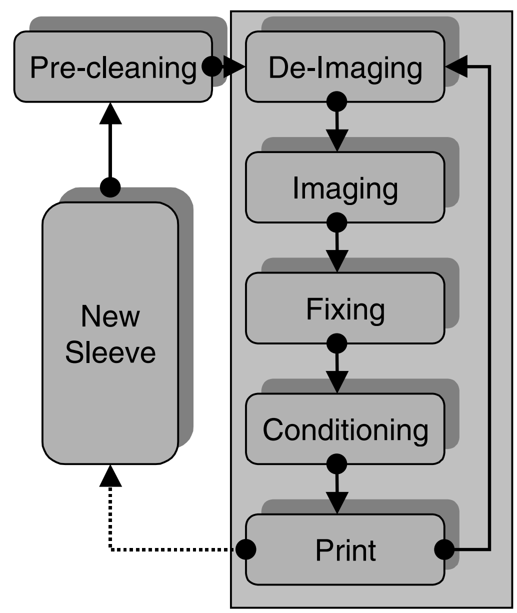

Figure 1. DICO Cycle

Imaging: The thermal transfer tape carries a special polymer coating. The tape comes into contact with the blank cylinder surface. Then a high resolution infrared laser heats up the coating point by point, according to the digital image data, transferring the ink-receptive material to the print forme cylinder.

Fixing: Once the imaging operation is finished the transferred material is fixed by heating it in order to obtain better adhesion to the substrate to ensure the run length stability.

Conditioning: This step improves the lithographic properties of the steel surface. After that the printing form is ready for conventional wet offset printing.

The additional pre-cleaning step on the left side of Figure 1 is only necessary if a new forme sleeve is brought into the machine. The estimated lifetime of a forme sleeve is above 200 cycles. Up to now we never reached the end of the lifetime of a forme sleeve during normal operation even after 500 cycles. If a sleeve had to be replaced it was destroyed by a mechanical accident.

Surface Conditions

Wet lithography as used in the DICOweb is in principle a surface energy driven process. Therefore the surface conditions of the image and the background are the determining parameters. During the DICO cycle two steps are of particular interest due to their surface states:

Ready to Image

After the previous print run has finished the plate cylinder has to be cleaned. This is the basic step for a reimageable printing process. We use a two step procedure:

1. First the residual ink has to be removed from the forme sleeve.
2. Then the polymer which forms the image is erased by the use of a environment-friendly de-imaging liquid. This is specially adjusted to the chemistry of the polymer.

Due to the fact that offset inks offer a huge variety of different types and that one can not exactly predict the amount and condition of the ink lasting on the image after the print run the cleaning of the ink is more difficult than the de-imaging of the polymer. Residual ink which is not completely taken off from the forme cylinder leads to toning or reduced adhesion of the new image. In both cases incomplete removal of the ink will result in a damaged image of the next job. For that reason the de-imaging step of the DICO cycle is designed in a way that the optimal cleaning result is ensured in any case. After the de-imaging step the surface of the printing form is in the *ready to image* state which means that the surface energy has reached the highest level.

Figure 2 shows a diagram of the principal pattern of the surface energy of the background. This model was obtained from numerous measurements of the contact angle and the surface energy of the forme cylinder during the various steps of the DICO cycle. We reach a level of the surface energy in the range of 60 mN/m.

Ready to Print

After the imaging and fixing the print contrast is going down (1), due to some microscopic contamination during the transfer process and the subsequently heat treatment of the fixing. The conditioning step enhances the print contrast back to the optimum level (2). Now the image and the background are ready for the wet lithographic printing process.

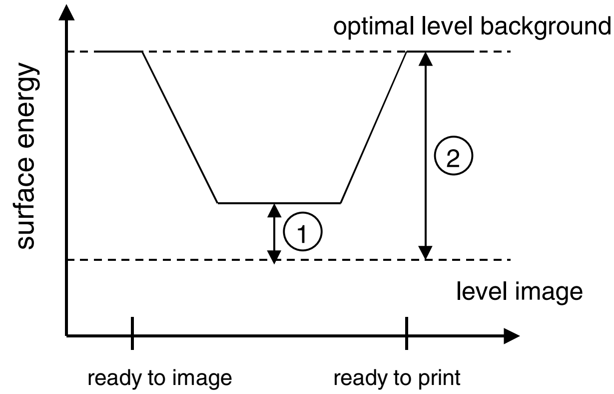

Figure 2. Principal pattern of the surface energy of the background during the DICO cycle. 1: Print contrast after imaging and fixing, 2: Print contrast before start of print run

Image Quality

In offset printing many parameters are determining image quality such as: image resolution, screening, paper quality and at least a huge variety of press conditions. We will focus on the special quality parameters which are related to the laser induced thermal transfer because this on-press imaging system is completely new.

Resolution

Thermal transfer printing is a well established method of image formation, mainly used for direct printing onto substrates, as in barcode printers and many others. With the laser induced thermal transfer we reached a complete new level in terms of resolution and quality. In case of the DICOweb a 3200dpi print head from CreoScitex is used for the image generation.

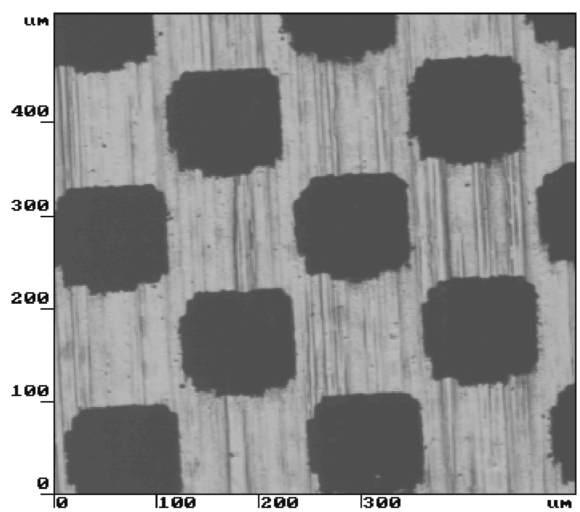

Figure 3. 40% raster dots on the printing form

In the DICOweb configuration the single spot size of this printhead is 8 by 4 µm with the smaller length in circumference direction of the cylinder. Figure 3 shows a microscopic image of a 40% raster area with a 60 lpi screening. With the small steps at the edges of the dots it is possible to recognize that the thermal transfer process is able to reproduce the resolution of the printhead on the substrate. This is the precondition to achieve good image quality and gives the capability to print with stochastic (FM) screening.

The profile section in Figure 4 shows the well defined edges of the small dot and its homogeneous material distribution. The height of 1.5 µm corresponds with the value of conventional printing plates.

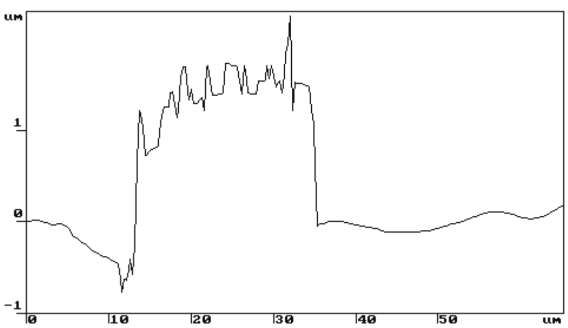

Figure 4. Profile section of a 1% raster dot

The above profile and the following image were measured by a scanning white light interferometer. This contactless surface topology measurement technique is based on a microscope with special lenses in which interference between a reference and the sample beam occurs. After reflection, the beams recombine inside the interferometer, undergoing constructive and destructive interference and producing the interference pattern. Vertical scanning generates a three-dimensional profile of the surface, which is processed by a computer and transformed in a quantitative 3-D image. The vertical resolution of these measurements is below 1 nm.

Run Length Stability

Apart from the resolution the image stability is another important quality parameter. The criterion which determines the run length stability is the existence of the 1% raster dot area, we define the end of a print run with the complete disappearance of a 1% raster dot control area or if a 2% area is only present by the half.

During our investigations we found out that the mechanism which determines the run length stability of the image is a mechanical removal of the image material from the top of the dot. If the height of a pixel falls below a critical level this dot is no longer able to print out. In Figure 5 the profile of an image dot was measured before and after the print run. At the beginning the height was 1.5 µm, at the end of the print run the dot was below 0.5 µm. The achieved run length stability in this case was 75.000 copies. For this experiment the DICOweb was equipped with an experimental short inking train to reduce the mechanical slip between the forme cylinder and the inking roller. If we use a conventional long inking system with four ink form rollers the run length stability is 30.000 copies.

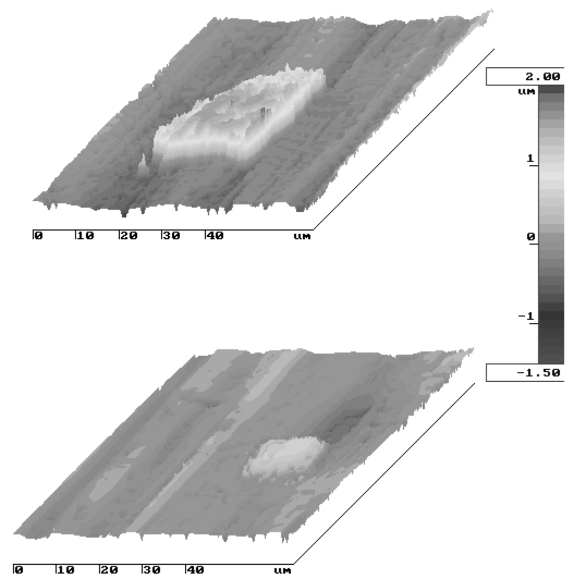

Figure 5. 3D Profile of a 1% raster dot before the print run and after 75.000 revolutions

In addition to the mechanical conditions of the printing press the used printing materials like ink, fountain solution or paper are also influencing the run length stability but their impact is less critical.

Generally the model for the print run stability consist of two main parts: the more material the transfer deposits and the lower the mechanical slip in the press the higher the print run stability is. The material transfer can not be exceeded unlimited due to the restrictions of the transfer efficiency, therefore the other parameters have to be well controlled to achieve a good run length stability.

Dust

One major concern about using thermal transfer methods for the generation of offset master plates was the occurrence of dust and the thereof resulting image defects. During the imaging process two types of dust related problems can occur: contamination of the surface with particles from the surrounding (e. g. paper dust) and emissions caused by the transfer process itself, which are deposited on the forme cylinder.

The influence of contamination from the environment is reduced by the fact that the imaging step follows immediately after the cleaning when the surface is in the optimal condition. The rotation of the plate cylinder during the imaging process also avoids the adhesion of dust particles on the surface.

Because of the thermal nature of the process, gas is generated which increases the gap between donor and substrate sometimes leading to poor image quality. With the DICO process we avoid these intrinsic problem by the use of a special configuration of the contact zone (see Figure 6). There is only a small active area for the transfer, 1.6 mm wide and 4µm in height. In addition to the sliding contact between ribbon and forme cylinder an air jet flows from the back side on the ribbon and presses the foil in the nip to the cylinder to ensure a good contact between donor material and substrate.

Due to this air jet and the movement of the ribbon and the printing cylinder resulting in a high relative speed, all of the arising gas and dust are lead away from the contact zone. Compared to previous attempts with the complete coverage of the substrate with the transfer foil this configuration has the advantage that tenting or gas bubbling can not arise. This dynamic process is advantageous to a static situation.

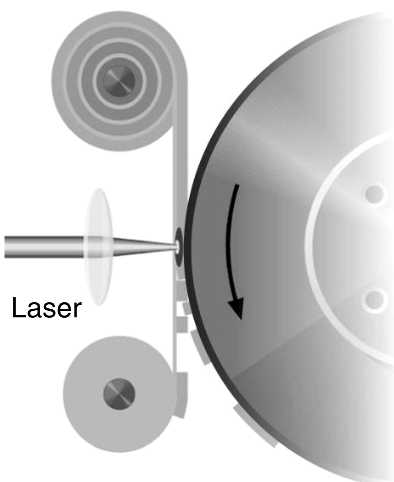

Figure 6. Transfer contact zone

Depending on the process parameters as laser power, ribbon or cylinder speed the laser induced thermal transfer shows a transfer efficiency between 70% and 90% of the donor material. Other plate making processes based on ablation of material from the printing plate have to vaporize or remove 100% of the material according to the image data. In contrast to this the DICO process only moves the material which is effectively necessary and minimizes therefore the appearance of dust and gas problems.

Conclusion

A reimageable offset master process has to face two major challenges: cleaning the surface after the print run and avoiding any defects during the imaging. The DICO laser induced thermal transfer solves these problems through a closed loop of tuned steps. In combination with the special geometry and the small size of the dynamic transfer zone the range for possible defects is minimized.

The amount of material in the image dots and the mechanical stress during the print run limit the run length stability. By the use of an optimal set of parameters for the transfer and good press conditions in terms of reduced mechanical slip the run length stability reaches a satisfactory level.

Acknowledgements

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References

1. Josef Schneider, et. al., *Proc. IS&T NIP11*, 1995, pg. 291.

Biography

Michael Schönert got his Diploma in Physics from Augsburg University in 1995. Since then he is working for MAN Roland in the development of new printing technologies. He investigated the quality parameters of the printing process and the run length stability.

Alfons Schuster got his Diploma in Physics from Augsburg University in 1995. Since then he is responsible for the development of the thermal transfer process of the DICOweb at MAN Roland.

Josef Schneider studied Physics at the Technical University in Munich. In 1980 he received his Doctorate for which he also received the 1981 Research Award (Robert Luther Award) of the Deutsche Gesellschaft für Photographie (German Association for Photography). From 1980-87 he was with the Fogra Institute in Munich. Since 1988 Dr. Schneider is working for MAN Roland Druckmaschinen AG, Augsburg, building up the Research and Technologies Department. He received the “Innovation Concept Award” of the Seybold Conference 1995, USA for DICOweb Gravure. In 2000 he won the first-place Prize of the Berthold-Leibinger-Innovation Award for his work “Lasers and digitally changed printing systems” in applied laser physics.