STUDY OF IMAGE MICRO-LINES REPRODUCTION QUALITY ONTO DIGITAL OFFSET PRINTING PLATES

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Abstract

The quality of reproduction of binary image elements in the computer-to-plate systems is very important for high quality of prints. Accurate reproduction of printing elements is of a particular importance in order to print a wide range of high-quality documents with fine image elements or micro-lines. This paper presents the results obtained from the study on the quality of the micro-line reproduction using computer-to-plate systems and thermo-sensitive printing forms produced in these systems applying IR (infrared, 830 nm wavelength) laser technologies.

The quality of reproduction of micro-lines on the printing forms, as well as on the final version of the printed document on the print material, is determined by a number of factors such as parameters of the computer-to-plate recording system, properties of the printing forms, etc. The aim of this study is to evaluate the quality and accuracy of the reproduction of the micro-lines taken into consideration the nature of the printing forms when the micro-lines are arranged parallel or perpendicular to the direction of the image recording.

Keywords: *offset printing form, thermo-sensitive printing plate, binary image element, image micro-line, computer-to-plate system.*

Introduction

Modern computer-to-plate systems designed for the production of offset printing forms use a variety of printing plates, which differ in their physical, chemical and structural properties. Under production conditions, this complicates the optimal selection of the printing plates when it is important to ensure high print quality for a particular segment of the printed production. The choice is also complicated by the fact that it is necessary to take into consideration not only types of the printing plates and their technological properties, but also to evaluate the capabilities of the printing form production equipment. The properties of the printing plates and technical parameters of the printing form production equipment define integral characteristics

of the printing forms quality such as image gradation, its range, reproduction accuracy of graphic image elements, minimal sizes of the image elements, width of micro-lines, including differently oriented on the printing forms, e.g. arranged in parallel and perpendicular direction of the image recording, etc. (Саек et al, 2017; Sajek, 2014).

Under production conditions, the use of Digital Control Wedges for printing forms is insufficient to define the quality of the image elements reproduction on the printing forms. In order to reliably predict reproduction quality of different sized image elements on the specific type of the printing forms using the specific parameter's device, modulation transfer function can be applied (Саек et al, 2017; Андреев, 2007).

The study is aimed to analyse the properties of the offset positive thermo-sensitive printing plates widely used in the printing industry when the image is recorded in a computer-to-plate device using IR wave laser. The paper presents the results obtained from the study on integral quality indices of the printing forms e.g. differently oriented micro-lines on the printing form. In the course of the study, the impact of the selected recording mode on the reproduction accuracy of the different orientation micro-lines was determined.

Material and Methods

In the course of the study, the reproduction of image micro-lines on thermo-sensitive printing plates *Fuji LH-PCE Brillia* and *Fuji LH-PJE* were analysed. Computer-to-plate equipment *Creo Trendsetter 800 Quantum* and *Creo Lotem 800* were used to record the image on the printing plates. The obtained experimental data were used to evaluate technological capabilities of printing plates. In addition, the impact of the image recording parameters on reproduction-graphic characteristics of the printing plates were assessed.

The printing plate *Fuji LH-PCE Brillia* was used for the positive image recording e.g. the active non-printing image element is formed as the result of thermo-destruction process when the layer is exposed to IR radiation. Later on, this layer is removed during the development process. The manufacturer indicates high technological and reproduction-graphic indices. In the presence of screening liner of 200 lpi, the minimum width of a reproducible stroke line is specified at 13 μm. On this plate, a special digital image control strip was recorded in *Creo Trendsetter 800 Quantum* plate-setter with micro-lines arranged parallel and perpendicular to the recording direction. On the digital image control strip were arranged separate micro-lines (their width ranging from 10 to 35 μm, when a step equal to 5 μm), in addition to linear structures that form periodic grids designed to determine resolution.

The width of the recorded micro-line was 10 μm and 15 μm, accordingly. In addition, 100 μm width micro-lines were recorded.

In the course of the experiment, the variable parameter was power of the laser imaging head which varied from 11 kW to 21 kW (a step equal to 1 kW; the total laser power is indicated here and elsewhere). Drum rotation speed (230 rpm), image recording resolution (2400 dpi) and screening liner (150 lpi) were constant parameters. A digital image control strip was recorded in stages starting at 11 kW. Using this method, a digital image control strip was recorded 11 times in 11 different modes. After recording, a printing form was developed. Prior to the measurements, gum solution was washed away from the printing form surface. The width of micro-lines was measured with a scanning electron microscope *Quanta 200* which resolution is 10 nm, enabling to magnify the image up to 10^5 times.

Under production conditions, image recording onto certain types of printing plates occurs by setting a constant parameter of laser radiation intensity. The intensity is altered if the printing plates are changed e.g. thermosensitive form material with different technical characteristics is chosen. In this case, after evaluating sensitivity to radiation of the form material, software installed in the form production equipment selects intensity of laser radiation suitable for printing plates of a particular type.

Results

While recording an image onto *Fujifilm LH-PCE* printing plates in the *Creo Trendsetter 800 Quantum* plate-setter, taking into consideration the sensitivity (170 mJ/cm^2) of these plates, it is important to ensure adequate energy density which corresponds to laser power of 16 kW. The width of micro-lines was measured on the printing form recorded using the above-mentioned power, and the obtained results are presented in Table 1 and Table 2. The results showed that micro-lines in the periodic grid are reproduced with significant geometrical inaccuracies (see Table 1). Inaccuracies are more significant of wider micro-lines arranged perpendicular to the recording direction, in contrast to the micro-lines of the same width arranged parallel to the recording direction. Fine separately arranged micro-lines (see *Table 2*) are reproduced with larger distortions when they are arranged parallel to the recording direction.

Table 1. Width of reproduced micro-lines of the periodic grid. Printing form Fuji LH-PCE, 16 kW

Micro-line orientation	**Parallel to the recording direction**			**Perpendicular to the recording direction**		
Micro-line width in the file, μm	10	15	100	10	15	100
Micro-line width on the printing form, μm	7,6	11,42	98,29	8,10	11,93	97,2

Table 2. Width of reproduced individually arranged micro-lines. Printing form Fuji LH-PCE, 16 kW

Micro-line orientation	**Parallel to the recording direction**		**Perpendicular to the recording direction**	
Micro-line width in the file, μm	10	15	10	15
Micro-line width on the printing form, μm	8,89	11,92	9,63	12,46

In addition, the micro-lines of 10, 15 and 100 μm width arranged in the periodic grid parallel and perpendicular to the recording direction were measured on the printing form *(see Table 3 and Table 4)*.

Table 3. Width of the periodic grid micro-lines arranged parallel to the recording direction. Printing form Fuji LH-PCE

Micro-line width in the file, μm	**Laser power, kW**					
	11	**13**	**15**	**17**	**19**	**21**
	Micro-line width on the printing form, μm					
10	9,04	8,20	7,84	7,64	7,12	6,84
15	14,82	13,24	11,76	11,06	9,92	8,68
100	100,85	99,57	98,51	97,87	96,84	95,4

Table 4. Width of the periodic grid micro-lines arranged perpendicular to the recording direction. Printing form Fuji LH-PCE

Micro-line width in the file, µm	**Laser power, kW**					
	11	**13**	**15**	**17**	**19**	**21**
	Micro-line width on the printing form, µm					
10	9,64	7,58	8,27	7,89	7,19	7,56
15	10,29	8,97	8,77	8,31	8,12	7,80
100	99,92	98,52	97,87	96,68	95,67	94,01

Based on the measurement data and chart (see *Figure 1*), it is obvious that the accuracy of reproduction in the periodic grid of 100 µm width micro-lines on this type of positive printing forms depends on the laser intensity and the direction of micro-lines arrangement. As the laser intensity increases, the width of micro-lines arranged parallel to the recording direction decreases, yet not so significantly, in comparison to micro-lines arranged perpendicular to the recording direction. Thus, it can be stated that the quality of reproduction of 100 µm width micro-lines is higher when they are arranged on the printing form parallel to the recording direction.

The width of 10 and 15 width micro-lines on the periodic grid decreases as laser intensity increases due to the direction of thermal energy diffusion, from directly exposed active non-printing areas to passive printing areas. These fine micro-lines are reproduced more accurately as they are arranged perpendicular to the recording direction.

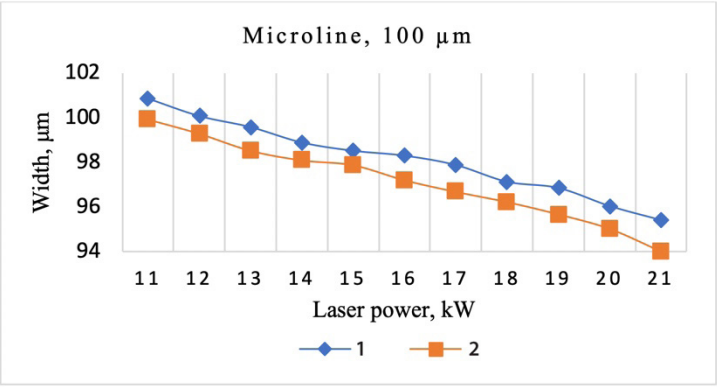


Figure 1. Dependence of the 100 µm width micro-lines variation of the periodic grid on laser power. 1 – parallel arrangement to the recording direction; 2 – perpendicular arrangement to the recording direction. Printing form Fuji LH-PCE

Separate strokes of 10 and 15 μm arranged parallel and perpendicular to the recording direction were measured (see *Table 5* and *Table 6*)

Table 5. Width of the separately arranged micro-lines parallel to the recording direction. Printing form Fuji LH-PCE

Micro-line width in the file, μm	**Laser power, kW**					
	11	**13**	**15**	**17**	**19**	**21**
	Micro-line width on the printing form, μm					
10	11,08	10,21	9,32	8,70	8,29	7,31
15	14,23	13,15	12,21	11,61	10,97	10,21

Table 6. Width of the separately arranged micro-lines perpendicular to the recording direction. Printing form Fuji LH-PCE

Micro-line width in the file, μm	**Laser power, kW**					
	11	**13**	**15**	**17**	**19**	**21**
	Micro-line width on the printing form, μm					
10	11,65	10,75	9,83	9,32	8,58	7,84
15	14,42	13,42	12,72	11,98	11,03	10,54

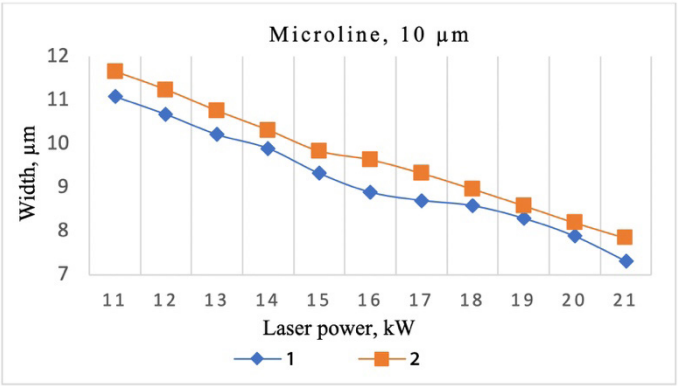
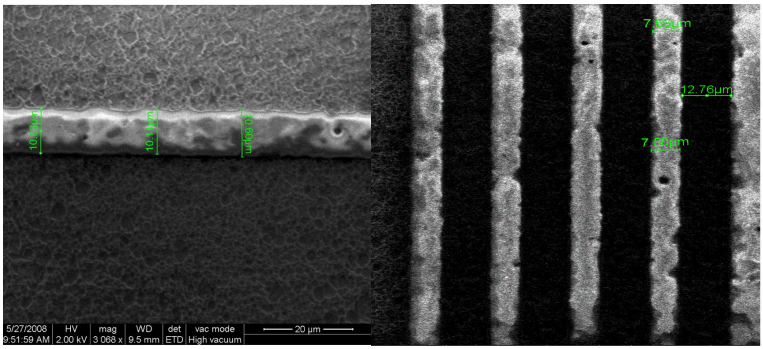


Fig 2. Dependence of the width variation of 10 μm micro-lines of the periodic grid on laser power. 1 – parallel arrangement to the recording direction; 2 – perpendicular arrangement to the recording direction. Printing form Fuji LH-PCE



a b

Figure 3. Micro photography of the 10 µm micro-lines: a – separate line; b – a periodic grid. Printing form Fuji LH-PCE

In order to confirm or refute the obtained results, the accuracy of the micro-lines reproduction on the thermo-sensitive positive printing plates/*Fuji LH-PJE*, which were recorded in the *Creo Lotem 800* device, were evaluated analogously. During this experiment, laser intensity and drum rotation speed were altered. By altering one or another parameter, the amount of energy reaching the plate surface is changed at the same time changing the size of image elements (Саек, Валчюкас, 2011).

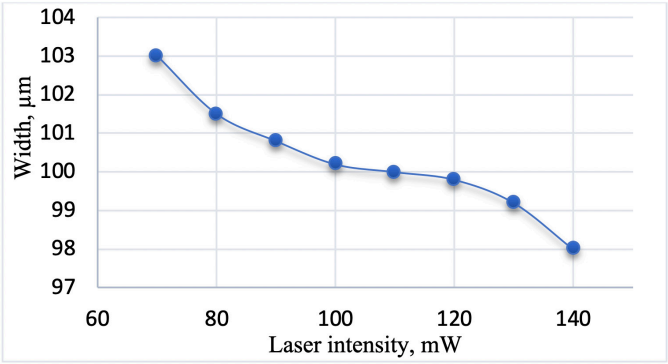


Fig 4. Dependence of the width variation of 100 µm micro-lines of the periodic grid on laser intensity, as lines are arranged perpendicular to the recording direction. Printing form Fuji LH-PJE, drum speed 900 rpm

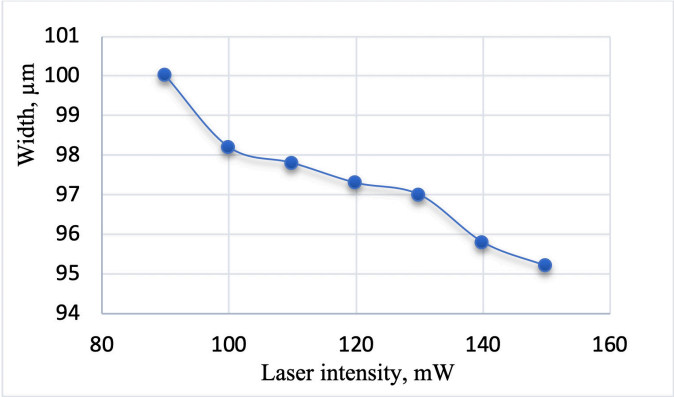


Figure 5. Dependence of the width variation of 100 µm micro-lines of the periodic grid on laser intensity, as lines are arranged parallel to the recording direction. Printing form *Fuji LH-PJE, drum speed 900 rpm*

As the obtained results show, the accuracy of reproduction of 100 µm width micro-lines is higher, if the micro-lines on the printing form are arranged parallel to the recording direction. In the presence of the optimal amount of energy, fine micro-lines of this type of the printing form are less distorted when they are arranged perpendicular to the recording direction.

Conclusions

The results of the study of the reproduction of fine image details (micro-lines) on the offset digital thermo-sensitive positive printing plates in the computer-to-plate systems showed that the width of recorded micro-lines depends not only on the laser intensity, drum rotation speed or physical and chemical properties of the printing plates, but also on orientation of the printing elements onto the printing form and the image recording direction at the computer-to-plate system.

The results of the study on the accuracy of reproduction of the micro-lines using printing plates Fuji LH-PCE Brillia and Fuji LHPJE showed the dependence of the reproduction quality on the orientation of printing elements on the printing form and the image recording direction.

In terms of the periodic grid of micro-lines, the wider micro-lines (100 µm width and up) are reproduced with significant inaccuracies, given the micro-lines are arranged perpendicular to the recording direction. Wider

micro-lines if they are arranged parallel to the recording direction are reproduced more accurately (see *Table 1, 3, 4*).

Fine individual micro-lines arranged parallel to the recording direction are reproduced not so accurately as fine micro-lines arranged perpendicular to the recording direction (see *Table 5* and Table 6).

The results correlate with previous studies of the quality of reproduction of image elements of offset thermo-sensitive printing forms (Sajek, 2014; саек, Валчюкас, 2011; Арутюнова et al, 2009). The obtained results can be applied in optimizing production processes of offset printing forms in order to achieve high-quality printed production.

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