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Investigation of relationships between the flexographic printing plate patterning and the anilox surface and volume in case of solid white ink printing on transparent materials

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Short abstract

This paper aims to explore the relationships between the flexographic printing plate surface patterning and anilox cell geometry and simultaneously searches for the solution to a genuine phenomenon in flexographic printing – to find an answer on how to achieve an optimal white underprint coverage.

Keywords: flexography, surface patterning, white inks, coverage, mottle

1. Introduction and background

Despite the massive expansion and development of digital printing techniques, the innovation is not dropped away in the branch of flexography at all. In the full width of the flexographic printing process, we can meet exciting innovations- fast, precise, more-economic printing machines, advanced ink recipes, ecofriendly materials, revolutionary aniloxes, etc.

Over the past two decades, in the production of flexographic printing plates, we could observe massive technological progress. The newest technologies in platemaking work with flat-top dots and nowadays we can choose from flat-top dots generated inherently by the plate material, or we can create them by different technologies where the absence of oxygen at the main exposure is essential for the creation of flat-top dots. Big advantages in quality can be achieved by the plate surface patterning. There exist many structures which are applicable on the plate surface helping to optimize the ink transfer and the ink laydown and supporting through that the achievement of excellent print quality.

Not only the contemporary technology is driving through changes, so do the market and the customer needs too. The market is becoming faster and faster because the customer today wants everything immediately, in good quality and cheap if possible. The technical progress aims to help printing houses fight the new trends successfully, but every step through the whole process needs to be optimized, standardized, and improved to the best possible level.

One of the challenges for the printing houses working with flexo technology is to print on different print surfaces with inks of different compositions to produce good quality prints. (Várza, Preklet and Horváth, 2021) A big part of flexible packaging materials is printed on transparent substrates, where white underprint is almost always a must. Displaying white color is a complex and difficult task itself if it is not examined in the active color display (on-screen), but from the aspect of passive (reflectional) printed colors. To reach the most optimal result during flexo printing, the coordinated operation of several elements of the process is necessary. (Várza, Preklet and Horváth, 2021; Borbély and Szentgyörgyvölgyi, 2011)

2. Materials and methods

In our research, we are examining how plate surface patterning and anilox cell geometry affect the white ink laydown, the ink coverage, and the visual ink porosity in the solvent-based and UV-based flexographic printing process.

For our research purposes, we have chosen two technologies often used in contemporary flexo printmaking practice – the Kodak Flexcel NX technology and the Pixel+ software solution from Esko combined with the DuPont™ Cyrel® Digiflow technology for flat-top dot plate making. To enable an outstanding print quality is efficient and controlled ink transfer crucial, which can maximize the color gamut and gives a great tonal range. Traditionally, for flexography was a problem to achieve pinhole-free ink laydown and a maximal color gamut and efficient ink use at the same time. The micro surface textures of flexo plates are solving this while they also transform the flexo ink transfer.

2.1 Printing plates used for the test

The Kodak Flexcel NX technology was the first of the modern techniques that came back with flat top dots in a "half-digital way". The Flexcel NXH plates can be used with a wide range of substrates and work with unique technology. The Flexcel NX Thermal Imaging Layer, utilizing unique imaging technology, and lamination: this combination provides high-resolution imagery on the plate, with 1:1 dot replication, and stable, predictable ink transfer. Digicap NX Patterning with Advanced Edge Definition enables good ink laydown control, expanding achievable color gamut and delivering better print contrast, improved tonal range, smooth solids, bright colors, and crisp text. (Miraclon, 2022) Because of more than 10 years of FNXH plate success, we have chosen this material to be one of our tested raw materials (Figure 1).

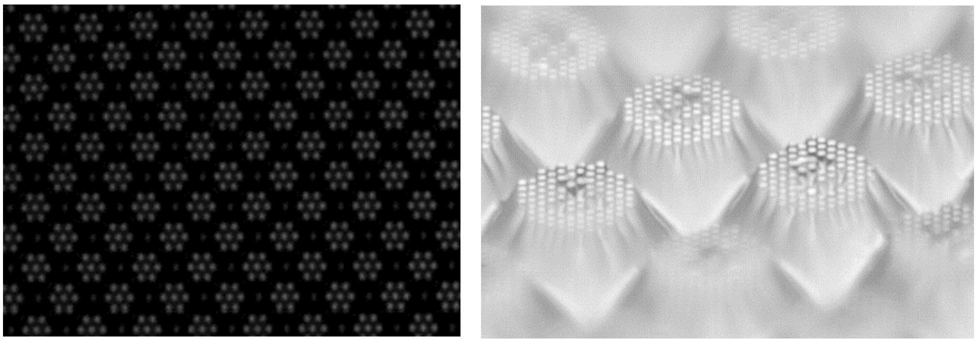

Figure 1: High magnification view of FNXH Digicap Patterning – Advanced pattern

For the case of the other technology – the Pixel+ - we had more variable possibilities. The microcell structure of Esko's Pixel + may be applicable on common digital printing plates, which need to be processed later on a specific technology to achieve flat-top dots – in our case on DuPont™ Cyrel® Digiflow or we can choose modern printing plates, where the capability of flat-top dot creation is included in the raw plate material and a classic plate making process is sufficient. In our test are 4 materials included with Pixel+ technology, two of them are classic digital plates and two have inherent flat top dot possibility (Figure 2). These five plates with different surface structures are tested in the printing process under different conditions. DuPont™ Cyrel® DPR plate is a digital solvent plate and can be used in a wide range of applications. Its durometer is 76 Shore A, and with the application of surface patterning and Digiflow technology, good results could be obtained. A similar, medium-hard printing plate is the DuPont™ Cyrel® DPN. It should have similar characteristics to the DPR plate, it has the same hardness, but according to our professional experience, this plate fits well for solid applications. Our third choice was the DuPont™ Cyrel® EASY ESXR plate. DuPont™ Cyrel® ESXR is the latest addition to the DuPont™ Cyrel® EASY platform with built-in flat-top dot technology for solvent processing. It´s a plate that is based on advancements to Cyrel® EASY polymer, that delivers high ink transfer and resolution (DuPont de Nemours Inc., 2019). The fourth plate selected for the test was the MacDermid LUX ITP™ 60. This plate was the first to market with an inherently flat-top dot technology for flexographic photopolymer plates. It´s a hard durometer photopolymer plate with its 78 Shore A, where no additional platemaking steps or equipment are needed to take advantage of the flat-top dots provide.

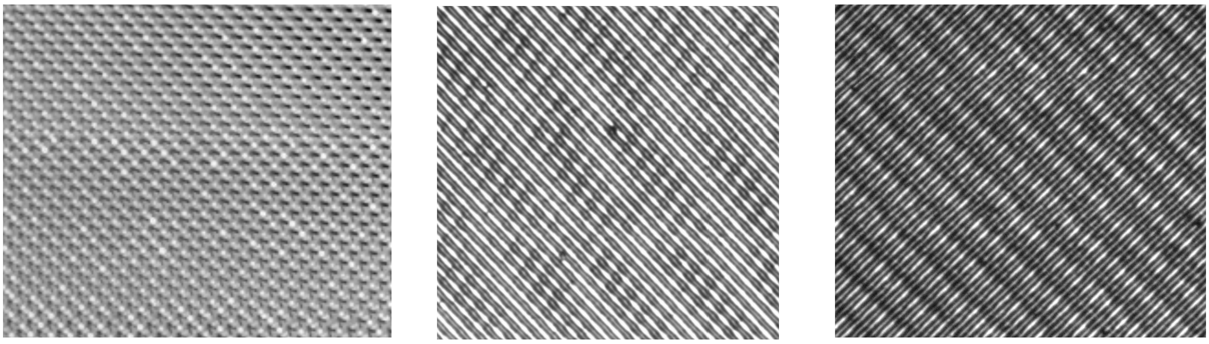

Figure 2: Photo of the MacDermid LUX ITP™ 60 plate and the MCWSI structure on the solid (left), the DuPont DPN plate with MG45 (middle) and the DuPont ESXR plate with MG34 structure (right)

Altogether, these five plates (FNXH, DPR, DPN, ESXR, ITP 60) with different surface structures are tested in the printing process under different conditions.

During our works we made a complete photography documentation of the printing plates we used in the test. All plates, all structures and all laser powers have been documented, but due to the limited space we show above a very few of them. Figure 3 illustrates the design of the printing plates.

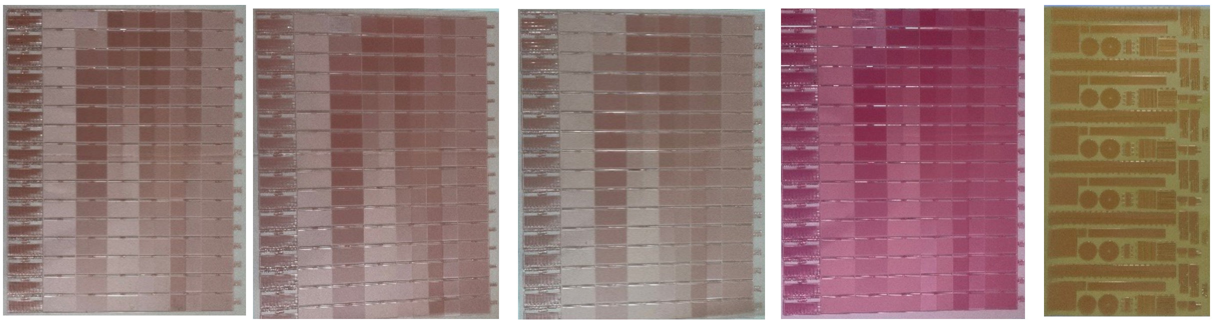

Figure 3: Photos of the printing plates used in the testing process

2.2 White ink printing in the flexography

In flexography is one of the most complicated topics the printing of the white underprint. It is no coincidence that one of the key points in improving print quality lies in the practice of using white inks, as there are many obstacles to printing in white.

The first printing problem is the coverage, the smoothness of the solid ink, which simply means the opacity and saturation of white ink. This is especially important if there are strong, contrasting colors to print, because with a poor quality white underprint on a transparent substrate the color-print will not be visible. If the white is weak, the packed product also can show through the packaging, which can spoil the imagined design and product appearance.

During our tests two types of white ink were used. The first one is a standard white UV ink for lamination and the second one is also a standard white solvent ink, where the print can be laminated in the later steps.

The sole function of the anilox is to ensure that a consistent amount of ink is delivered onto the printing plate, time after time. (Racey, 2016) For our research, we are using three types of anilox rolls – the classic 60°hexagonal, channel engraved, and high-volume process aniloxes with elongated hexagonal cells (Figure 4).

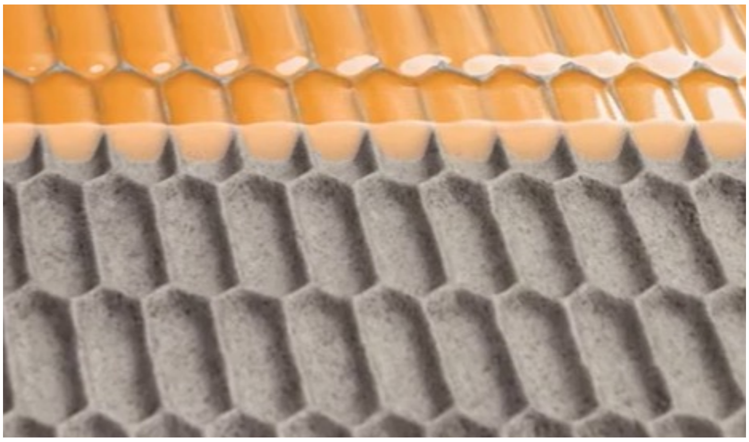

Figure 4: High volume process aniloxes with elongated hexagonal cells (Sandon, 2022)

The following anilox rollers were included in the test process:

- high-volume process with elongated hexagonal cells 200 lpcm / 12 cm^3/m^2
- high-volume process with elongated hexagonal cells 200 lpcm / 10 cm^3/m^2
- high-volume process with elongated hexagonal cells 160 lpcm / 14 cm^3/m^2
- classic hexagonal cells 60° 120 lpcm / 15 cm^3/m^2
- channel engraved (L) 10-11 cm^3/m^2
- channel engraved (XL) 13-15 cm^3/m^2
- channel engraved (M) 7-8 cm^3/m^2

Last, but not least we examined according to our possibilities the above-mentioned settings in a solvent-based printing process and in a UV-based printing process. The test for the solvent-based samples was produced on an 8-color Soma Midi Flex 2 machine and our UV-based samples were made on a 670 mm wide Bobst M6 printing machine.

3. Results and discussion

What we evaluated for the purposes of this research for both presses – the solvent-based and the UV-based – is the solid ink coverage. coverage. We carried out measurements on the test prints. During these examinations, we used an X-Rite NGH (eXact) spectrophotometer with D50/2°, M0(No) no filter conditions for measuring lightness. With our measurements we determined the coverage levels of the opaque white relative to each other. This means that we measured the achievable whiteness in CIE $L^*a^*b^*$ values after laminating onto a black base foil. Here, we examined absolute values, that is how much we could approximate the ideal colorimetric white ($L^* = 100$ $a^* = 0$ $b^* = 0$). The level of coverage always depends on the backing material. Under these conditions, we need to focus mostly only on the L^* value of the CIE $L^*a^*b^*$ measurements, and the absolute values of a^* and b^* need to remain less than 2–3. (Várza, Preklet and Horváth, 2021) We did the measurements for every printing plate and every pattern we used, to get the results on which patterning fits the best for the printing of the white underprint – we did it for solvent and UV separately. As the next step of our research, we will also evaluate the mottle effect on the printed samples, because not only the solid ink coverage is an important factor to evaluate, but it has to be examined together with the mottle – these two factors together build up the visible result of a solid. Further, we evaluated the influence of the anilox cell geometry and the ink volume that influences the quality of the white underprint.

It is not necessarily true, that a print squeaking in ink is the best solution for a white print. Moreover, if the white separation would contain vignettes, the situation would become even more complicated. For this article we don´t discuss any fades and vignettes, we are just dealing with the solids, but we plan to extend our research further to this topic too.

Based on the measurements of 2 730 measuring points, we made the following findings:

- For the solvent based flexo technology the best coverage was achieved by the DuPont DPR plate and with the high-volume process anilox with elongated hexagonal cells 200 lpcm /10 cm^3/m^2. The winning structure was the MG45 at a very low – 110 % laser power. In addition the MacDermid ITP60 plate was performed also outstandingly.
- In the UV printing process we got the best results with the DuPont ESXR plate and the channel engraved anilox (XL) 13–15 cm^3/m^2. The best surface structure performance was given also by the MG45 at 110 % laser power. We could observe very high values also in the case of the MCWSI structure on the same (ESXR) material.

In the Table 1 and Table 2 we present our measurement data (L^* values) for the winning samples.

Table 1: Data of the sample with the best results in the UV printing process

Printing plate: ESXR		Printing process: UV		Anilox: XL		
Laser power (%)	MC16P	MG25	MG45	MG34	MCWSI	Solid
100	82.04	82.37	78.75	82.89	43.57	82.04
110	82.12	82.43	82.95	82.75	81.90	82.09
120	82.08	82.38	82.85	82.51	82.65	82.06
130	82.09	82.40	82.68	82.33	82.69	82.00
140	82.12	82.42	82.63	82.24	82.67	82.04
150	82.16	82.43	82.57	82.23	82.65	82.01
160	82.17	82.44	82.56	82.03	82.55	82.03
170	82.13	82.47	82.52	82.01	82.53	82.12
180	82.20	82.52	82.46	82.04	82.50	82.10
190	82.31	82.59	82.50	82.01	82.44	82.07
200	82.23	82.56	82.44	81.96	82.44	82.24
210	82.25	82.47	82.37	81.92	82.26	82.05
220	82.23	82.48	82.41	81.97	82.28	82.11
230	82.16	82.49	82.34	81.96	82.18	82.05
240	82.24	82.45	82.27	81.92	82.09	82.16
250	82.18	82.49	82.22	82.00	82.07	82.19

Table 2: Data of the sample with the best results in the solvent printing process

Printing plate: DPR		Printing process: Solvent		Anilox: 200/10		
Laser power (%)	MC16P	MG25	MG45	MG34	MCWSI	Solid
100	75.15	76.42	75.50	76.12	68.77	76.01
110	74.87	76.40	79.96	76.29	75.23	75.94
120	74.75	76.40	76.41	76.28	75.96	75.74
130	74.72	76.41	76.35	76.26	76.61	75.74
140	74.89	76.41	76.28	76.11	76.74	75.76
150	74.90	76.38	76.28	75.94	76.72	75.77
160	74.85	76.43	76.16	75.88	76.65	75.71
170	74.82	76.37	76.06	75.91	76.56	75.57
180	75.02	76.32	76.04	75.80	76.53	75.61
190	74.87	76.21	75.99	75.58	76.26	75.72
200	74.96	76.15	75.73	75.57	76.22	75.54
210	75.87	76.08	75.83	75.75	76.19	75.62
220	74.71	75.97	75.85	75.72	76.17	75.57
230	74.94	75.96	75.85	75.75	76.10	75.56
240	74.98	76.21	75.61	75.86	76.02	75.53
250	75.11	76.12	75.76	75.92	76.20	75.59

We can overall determine, that for the conditions of the material types and equipment we used in solvent technology fits the DuPont DPR plate and for the UV technology is the DuPont ESXR plate the best solution for the coverage.

4. Conclusions

When we sum up everything, the goal of our research was to determine the configurations of the printing process with the usage of our specific technologies. We aimed to find out which of the settings can result in the most perfect product using the least possible amount of raw material.

Based on our measurements, we determined the optimal and economical white ink application options for the conditions we used and found that by using them, we can achieve a significant improvement in quality and ink savings. The high print quality is also reflected in the fact that we did not realize any ink smudging.

As a result of the last world events, increasing market and economic uncertainty encourages us all to be thrifty. In addition to all this, the role of environmental awareness is becoming more and more prominent these days, so it is important from several points of view to achieve the best results in terms of both material use (economy) and scrap production (quality) during the production of our products. We are confident that our research represents a big step forward in this regard.

Hopefully despite the crises of the last period the doors will remain open to numerous new research and development projects in the future. Thus, our plans with this research are to help to improve the quality of flexographic printing and our future research plans include the creation of new surface patterns, printability analysis of text elements, the study of prints with certain screen types, printing optimization and standardization and the examination of the possibilities of increasing ink coverage.

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