The Evolution of Flexo Platemaking and the Application and Implications of Full High-Definition Flexo

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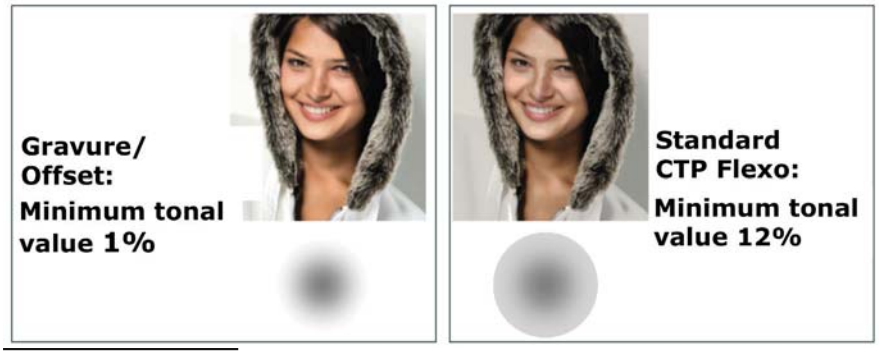
Keywords: control, flexo, flexo platemaking, dot, density, ink, spot color

While flexography is a very cost-effective print process particularly for packaging, there are times when there have been other preferred print processes, especially as it relates to print quality.

So what has prevented flexo printing from matching the 'high quality' processes like gravure and offset? It is the tonal jump at the end of a vignette to zero, caused by the fact that even digital flexo plates can only correctly print dots above a specific minimum size.

With 4000ppi imaging technology, it is possible to easily hold 10-micron dots on digital flexo plates, but unfortunately these dots are not mechanically stable enough. They bend or squeeze during print. Thus, transitions to zero—as well as very light image details—cannot be printed with today's standard flexo printing process. We call this the 'Flexo Problem'.

What can be done to overcome this basic and major limitation that often prevents flexo from taking more market share from offset and gravure?



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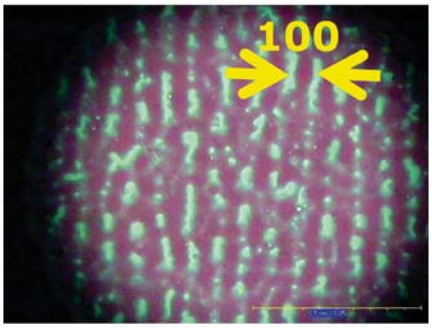
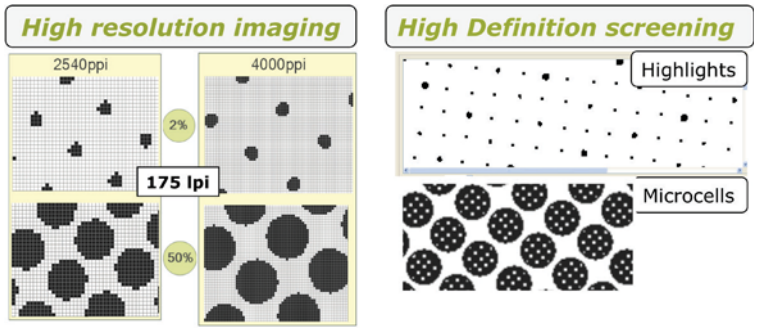
This 'Flexo Problem' can be cured by HD technology, but there are other basic problems that occur in flexo printing. One of the most important is the incomplete ink lay down in flexible packaging printing of foils with solvent inks.

Ink lay down is typically influenced by the 'self-organization effect' of the ink due to surface tension. This causes the ink film to tear into cells of about 100 microns in size, and the print speed transforms these cells into lines. The result is visible defects on the solids (so called 'pinholes') that reduce the flat appearance of solids and overprints—and even Pantone builds. Furthermore, it leads to a reduced solid ink density (SID) in general. This often makes it necessary to separate linework and process work into two separate plates, printing linework with higher volume anilox rollers to increase the solid appearance. However, this also has a tendency to reduce the highlight quality. Especially for underprints or overprints, the white is often printed twice. All in all, the lower quality appearance to the human eye often results in a selection of a different print process—meaning much higher costs to the printer and the brand owner.



When Esko introduced its CDI flexo plate imager in 1995, the typical imaging resolution was 2100 pixels per inch (ppi; also known as dots per inch). At this time, an 18-micron spot was the standard. Over the years, the resolution has been increased, while the writing spot size has concurrently been reduced. This not only means that we have 4000 ppi addressable pixels per inch but also that each pixel is accurately written with a 6 micron spot.

What are the advantages of increasing the imaging resolution?



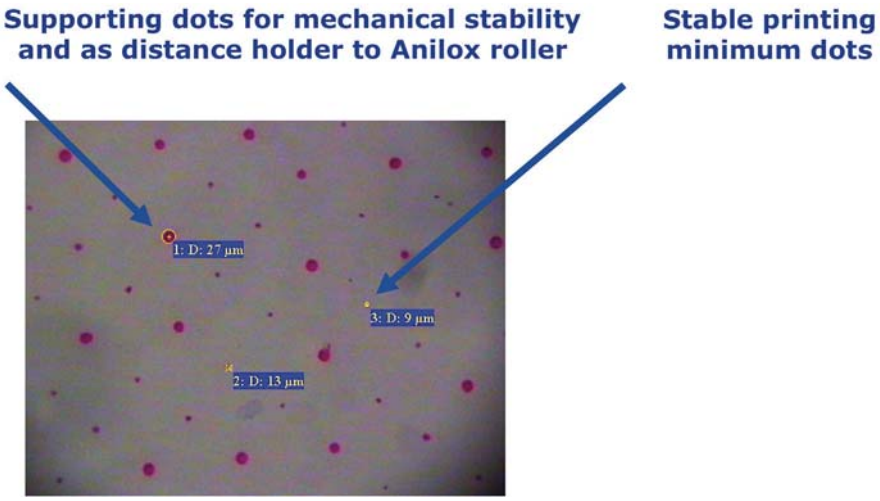
(sub) HD Flexo explained

An answer to the 'Flexo Problem' can be found in HD Flexo. HD Flexo uses a well-balanced dot size mix of small and large dots in the extreme highlights. The rest of the tonal scale is not changed. Thus we can make use of the full grey-level support of 4000ppi. The dot size mixture produces two benefits:

1. There are a few larger dots—even larger than the typical minimum dot size in standard screening. These dots are so stable that they can easily withstand the forces of the impression during the print process.

2. The other dots in the grid are smaller—some are 10 microns in size, or smaller. In fact, the image below consists of about 30 different dot sizes. The smaller dots are supported by the larger dots and, thus, do not bend on the press, so they can deliver tiny printed dots maintain stability even during long runs. Depending on the print process, the HD method reduces the tonal values of highlights to near zero.

This mixture of large and small dots—where all dots stay on their regular grid—is confusing the human eye, so the eye only sees a homogeneous 'grey'. This is in strong contrast to previous stochastic screen models, which use a smaller amount of dots when the tonal value is below that which is possible with standard screening. The penalty for this lower dot frequency is much more visible graininess in the highlight areas, especially when several colors are printed together.



HD screens only allow the smaller dots to fade away (and thus lower dot frequency) at the extreme end of a vignette to zero. This only appears on the last millimeter of a vignette edge and this does not interfere with the perception to the human eye. All larger areas are always printed with all dots on their regular grid, which makes the dot structure invisible to the human eye.

HD technology only works for digital flexo plates, as the dot sharpening effect during processing delivers this elevated amount of grey levels to stabilize the highlights tints properly. All technologies that use flat top dots (like conventional flexo plates, digital flexo plates produced under the absence of oxygen, or flexo plates produced with transfer films) cannot use the HD screening method. These plates can only be made with stochastic-like algorithms, as lower tonal values require a reduced number of dots. This is prone to a grainy appearance.

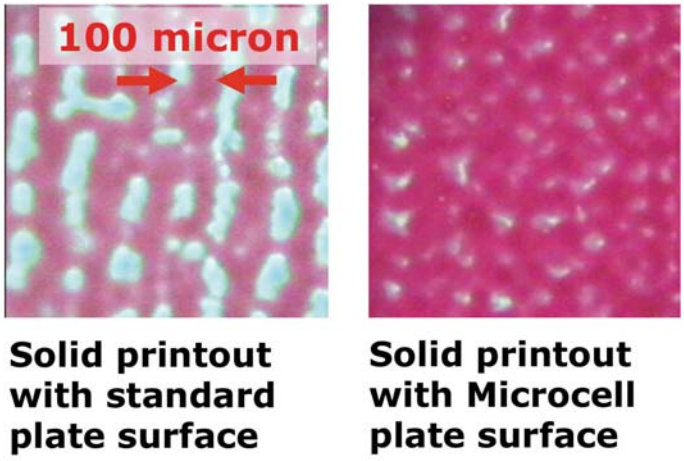
The best suitable dot size mix, of course, depends upon the plate polymer characteristics. To achieve this, HD Flexo supports each commercially available digital flexo plate and sleeve type with specifically tailored HD screens. An HD Flexo installer selects the proper screen for each digital flexo media and print process combination. This ensures an easy and straightforward implementation for trade shops and printers.

Here is a comparison between standard CTP Flexo and HD Flexo, printed on a commercial long-run job that was originally printed in gravure and has now been successfully converted to flexo whenever it is regularly reprinted.

The astonishing fact is that nothing needed to be changed except the platemaking. The job used the same plate type, the same processing equipment, the same mounting tape, the same press and even the same anilox rollers and inks. The only difference was the change of imaging technology – digital flexo @ 2540ppi and 150lpi circular screening versus HD Flexo @ 4000ppi and 200lpi HD screening. The standard flexo plates could not print at rulings higher than 150lpi because the minimum dot would have been far too high at 200lpi. However, HD technology ramped up to 200lpi easily, as the minimum dot in print was still close to 0%. The difference in the results is clearly outstanding!

The dot size variation technology of HD also brings the additional benefit of making flexo rosettes nearly invisible in the highlight areas. Even in the strong enlargement of the women‘s eye , flexo rosettes remain invisible in the HD Flexo image. This feature smoothens the printing appearance of the very sensitive highlight area.

Contrary to all former technologies, HD Flexo is generating plate surface structuring not only in the highlights, but also throughout the scale in the halftone screening dots. This enables an improvement in ink lay down for the total tonal range, without generating transition steps in gradations. Also the shadow areas can now hold more grey levels—and thus more details—as the ink does not close the small shadow holes any more. Thus, the printer can also benefit from more shadow details.

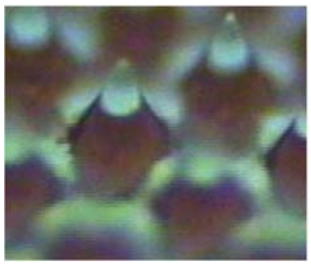


subhead) Round-top vs. flat-top dots

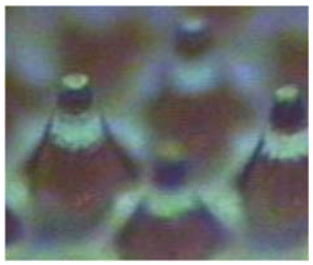
Unfortunately, while this is a substantial improvement, it is still behind gravure quality. What can be done? The answer comes with understanding round and flat top dots.

The advantages and disadvantages of round and flat top dots are currently being discussed intensively. The 'round top' dot shape is the natural dot shape of digital flexo (CTP) platemaking and is created by so-called oxygen inhibition. That is, the oxygen in the surrounding air blocks the polymerization reaction at the surface of the plate during UV main exposure.

This dot shape has boosted the development of the flexo printing process from a low quality process to a serious competitor to gravure and offset printing. Round top dots are always smaller than their openings in an imaged black Laser Ablatable Mask Surface (LAMS).


round top dots

The 'flat top' dot shape is well known from the analog days of flexo, when an imaged film was used for flexo platemaking. The film on top of the flexo plate blocked oxygen from accessing the photopolymer during UV main exposure. The result is that the dot grows 1:1 to the opening in the film.

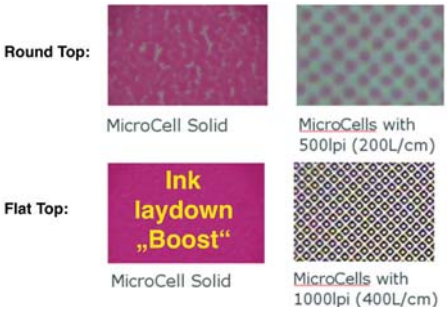

flat top dots

Recently other technologies have been developed to inhibit oxygen during UV main exposure. While these technologies use laminated foils or inert gas, all use conventional bank light frames for UV main exposure.

(subhead) Digital LED UV exposure

Oxygen inhibition can also be suppressed by a recently developed technology using very high intensive UV light. This technology can also generate a 1:1 dot formation although the UV main exposure process takes place under normal atmospheric conditions, without any additional manual and analog lamination steps.

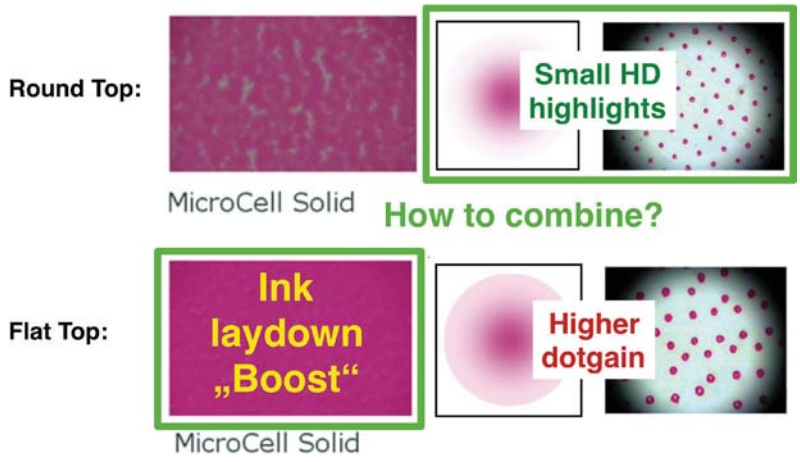
The round top dot shape has significant advantages in all flexo printing processes. Due to the sharper top, round top highlights print much smaller and lighter than flat top dots of the same size. Round top dots are the backbone of HD Flexo highlight printing. The capability to print transitions to zero has helped it to become the industry standard in flexography.



Flat top dot plates suffer in the highlights. Stochastic screening is often used to achieve lighter minimum tonal values, but the price for this is clearly visible graininess in the highlights.

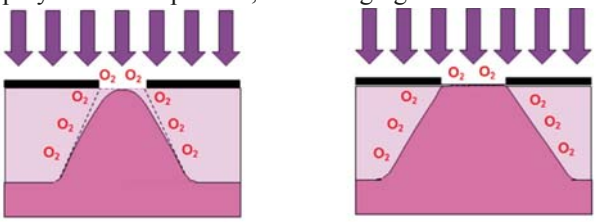
When we look at solid printing, the situation turns around. Microcells work much better with flat top dot plates than with round top dot plates. The result of flat top dot plates with proper microcell structures is a gravure-like ink laydown. The reason is that the 1:1 dot formation of flat top plates can hold much finer Microcell structures on the plate surface than is possible with round top plates. On round top plates, the top 20 micron layer of the plate is not exposed due to the so called “oxygen inhibition”, and removed during processing. This makes it impossible to hold microcells smaller than 20 microns in size.

So, the challenge has been, how to combine the highlight benefits of round top dots and the solid coverage of flat top dots.



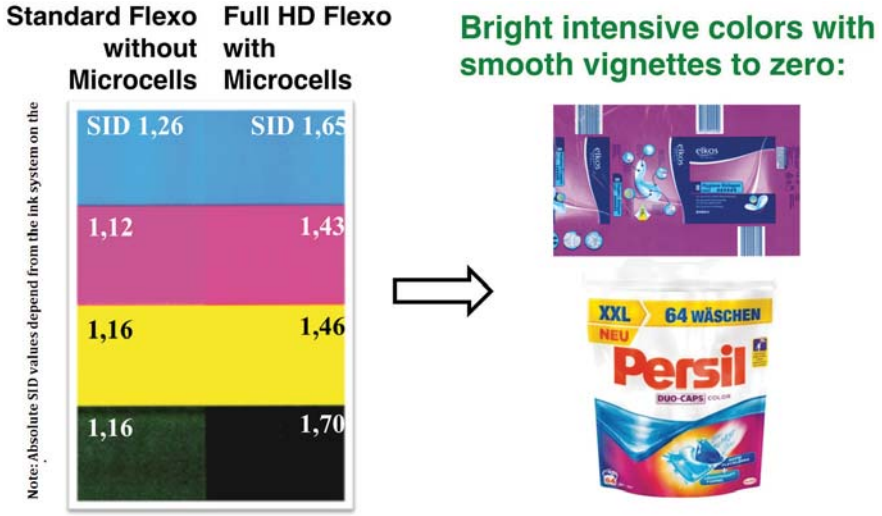
(subhead) The introduction of full high-definition flexo

Esko has developed a technology, called Full HD Flexo, which utilizes a digital high-power LED UV main exposure head inside the CTP imager. This offers full digital control over the oxygen Inhibition process by intensifying the UV light during main exposure, changing the surface speed during UV exposure — thus changing the polymerization process, and changing the dwell time of UV light.



With this unique UV control capability, it is possible to create small highlight dots that become round again – although larger dots stay flat. Full HD Flexo is the only technology that creates round top and flat top dots on the same plate – for perfect ink laydown in combination with smooth edge printing and transitions to zero!

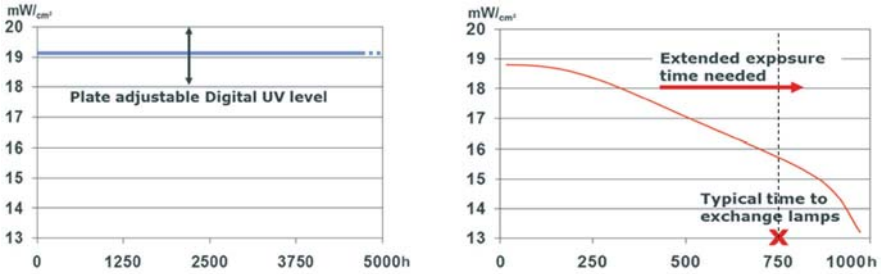
The ink laydown of Full HD plates and sleeves can compete with gravure printing in flexible packaging. Typically the Solid Ink Density (SID) can be increased by about +0.3, and in extreme cases by up to +0.6. The ink laydown in all areas of flexible package printing (solvent and water-based inks) is perfectly smooth without any pinholes. This leads to a very intensive appearance to the human eye. Full HD Flexo is also improving ink laydown in corrugated and label printing.



When using Full HD Flexo, the optimum solid ink density (SID) can be selected by the proper Microcell structure. This typically works even without the need to change the anilox roller on the press, thus delivering significant process and productivity advantages in the pressroom.

All of the Full HD Microcells eliminate the pinholes, especially in flexible package printing. Printing with a pinhole-free ink laydown and the correct SID also reduces ink consumption and solvents on the press to a minimum, and guarantees brilliant overprint colors without any blackening effect. From our experience talking with printers, the ink savings can be as much as 25%.

The other advantage of digital LED UV exposure within the unit is that there is consistent exposure. Bank UV frame light sources lose light power as time progresses. While exposure time can be extended as needed, it does have to be adjusted. Also, because light sources are not similar, exposure throughout the light table can be inconsistent. On the other hand, digital LED UV is a consistent light source that lasts over 5,000 hours, or enough for 30,000 plates. Each square inch of the plate receives the same light. Thus, for the first time ever, there is consistent dot quality in flexo platemaking!



(subhead) What's next?

By implementing internal UV main exposure, there is now the opportunity for 'lights out' flexo platemaking. With an attached plate stacker and plate handler, and plate output device, raw plates can proceed directly into the imager, get exposed, and be sent directly to the plate processor.

There are greater ramifications, though. One of the more costly processes for package printers involves printing with spot colors. Beyond the cost of mixing inks, the process requires the cleaning of units between runs and shuts down the press for a while—not to mention extended makereadies.

Because of this, flexo printers are now experimenting with simulating spot colors on press—either 4-color process or extended gamut printing, typically 4-color plus orange, green and violet. One of the benefits is that there is no cleaning of ink stations between jobs, because the printer is always using the same ink. There is a less waste of ink and solvents. There is also less time during job changeovers. With this, smaller run lengths become commercially viable. And, because the same inks are used for every job, the printer can combine different jobs on the same web. For the brand owner, besides the economic advantages, there is better flexo print quality. Images are brighter and higher line screens can be used for difficult areas, such as vignettes (if fine anilox rollers are also used).

There are a few prerequisites for this to happen:

- There must be a controlled and consistent ink laydown that corresponds to the ΔE requirements for matching brand colors.
- There must be no visibility of 'flexo rosettes'. The appearance of the spot color must be acceptable. This usually means that there must be a minimum of 150 lpi; although it is better if it is 175 lpi.
- There must be a perfect ink laydown with fine anilox rollers. Highlights, vignettes and bright solids must be reproduced on one and the same plate.

When using Full HD Flexo, the digital UV LED exposure assures a consistent ink laydown and consistent dot quality throughout the plate for exceptional line screens for packaging, in combination with spot color simulation.
This will soon become the future of flexo printing.