HD Flexo

Application Guide

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2. Introduction

This application guide defines the basic application guidelines for HD Flexo used from Color Pilot. HD Flexo offers proven HD Screening Sets for the majority of digital flexo plates. The HD screens are specifically tailored to the supported plate types to supply the benefit of both print quality improvement and ease of use at customers.

HD Flexo is targeting the high-quality flexo printing market. Up to now, supported application areas include label printing, flexible packaging, folding cartons and corrugated.

As HD Flexo is specifically tailored to the quality flexo market, supported line counts are 120lpi and above. In general, screen support is available for 120lpi, 133lpi, 150lpi, 175lpi, 200lpi and 225lpi; and a broader range of line counts is available for specific applications such as corrugated post-print.

It is mandatory that imaging of the digital flexo plates is done on a CDI device with HighRes optics (true 4000 ppi imaging).

One aim of HD Flexo is to extend the printable tonal range in combination with smooth transitions to zero in vignettes with a very smooth grey level appearance of the highlight areas and vignette edges. For specific applications such as flexible packaging, HD Flexo can also increase ink density in solid and shadow areas.

3. The CDI

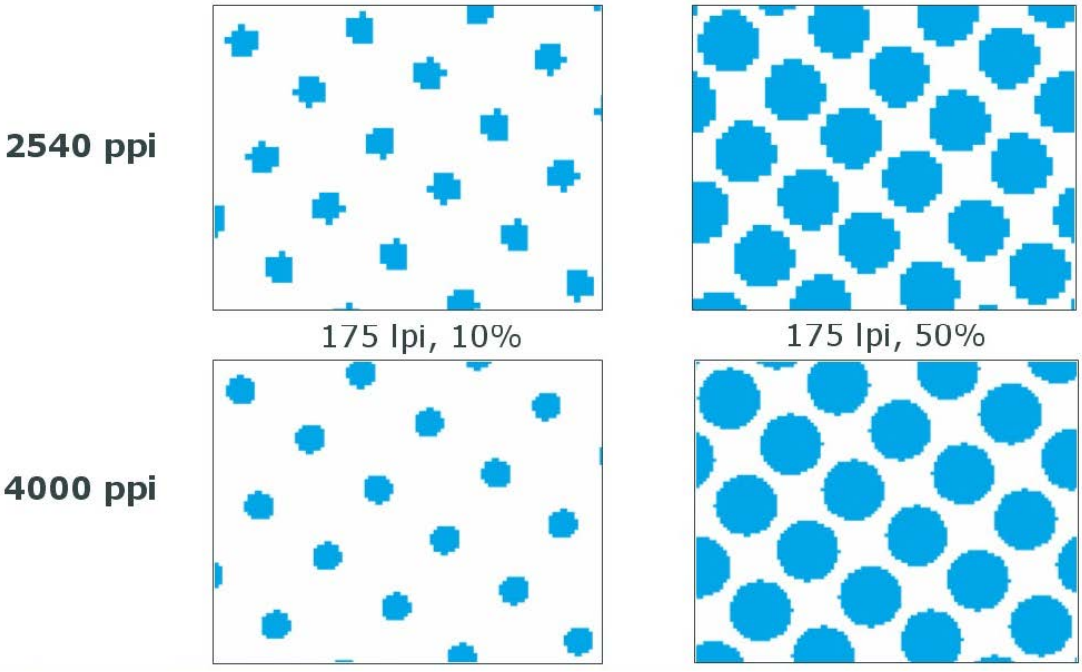
The CDI needs to be equipped with a HighRes Optic to enable a sharp 4000ppi imaging of the LAMS layer.

3.1. Advantage of the HighRes optic

Having more pixels available for a certain element leads to smoother edges and better definition of screening dots as well as for line work elements.

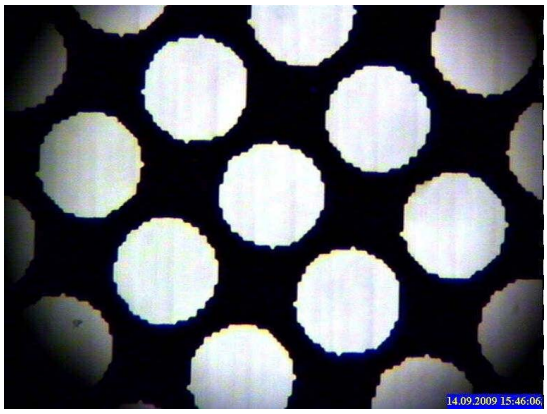
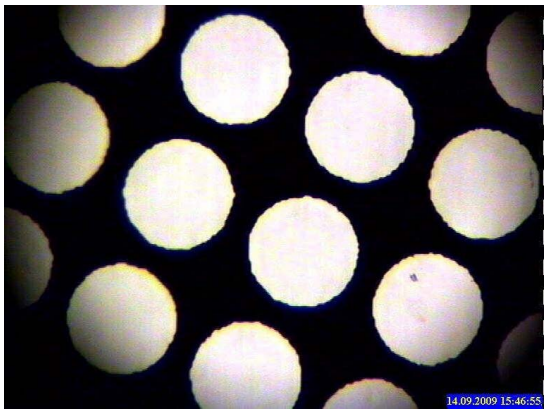
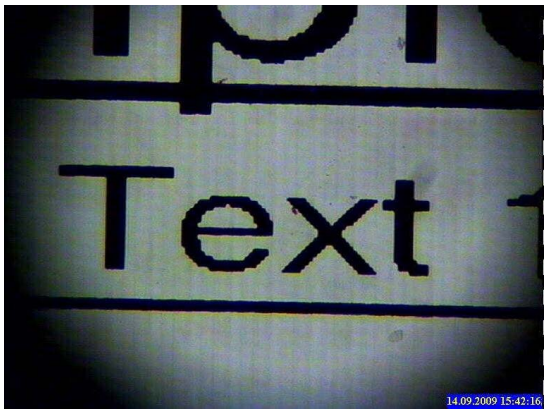
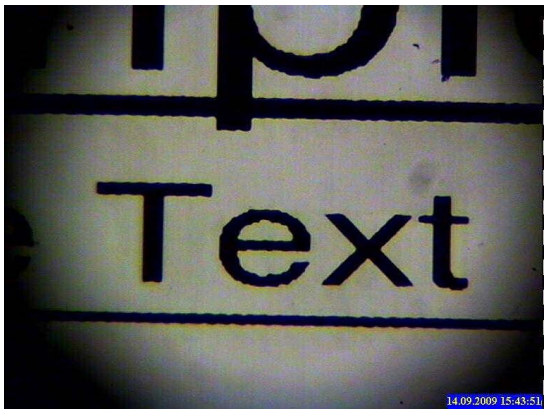
Especially for higher ruling (>= 120lpi), the rip is capable of realizing more grey levels which leads to increased contrast and detail sharpness of printed images. This is especially noticeable in the print in case the design requires a high change in tonal value over a short distance (e.g. short vignettes to zero or small images).

Furthermore, the dot definition is much better in the highlight area as well as in the mid-tones:



Thus smaller minimum dots can be held on the plate and printed reproducibly. Typical flexo problems like e.g. dot bridging are getting much less obvious, run lengths are increasing and cleaning effort is often reduced.

The following pictures taken from the black LAMS mask after imaging clearly show the increase in imaging sharpness:

2540ppi	4000ppi
	
50% field	50% field
	
Small text	Small text

The HighRes Optic is capable of imaging files between 2400ppi to 4000ppi. The productivity at 4000ppi is the same as on lower resolutions. However the limit is currently 6m^2/h.

3.2. Grapholas

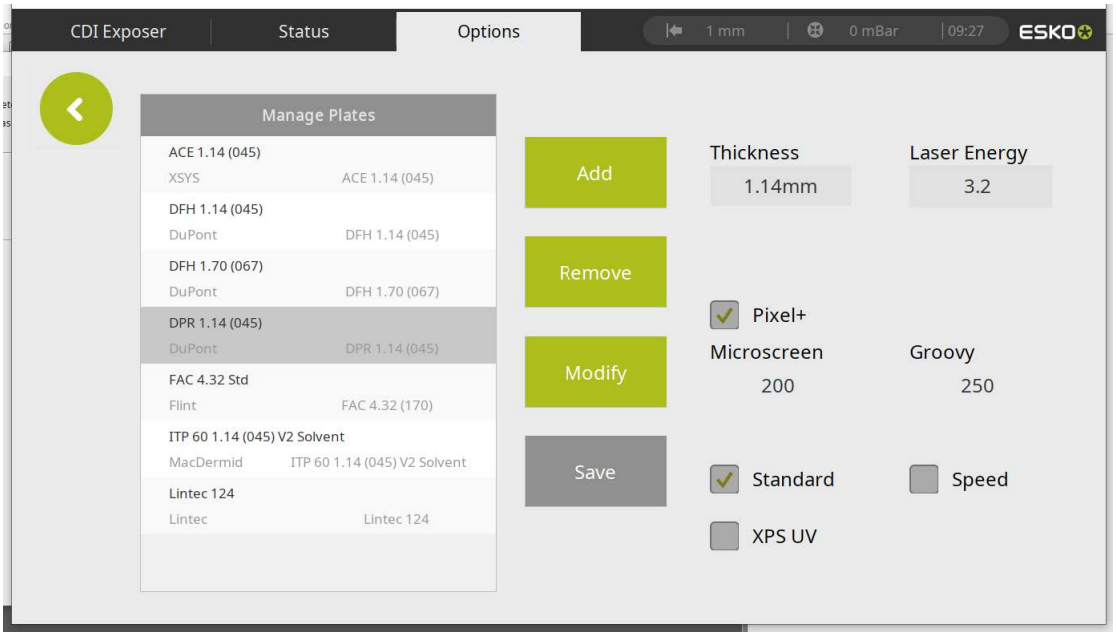
3.2.1. HD Flexo license

In order to be able to image HD Flexo lenfiles the Grapholas™ software on the CDI needs an HD Flexo license. This license is enabled during the installation or the upgrade and is delivered by Global Support Germany. To check if the license is present, open the Help – About Box in the Merge program.

3.2.2. Plate setup

If the customer is using the resolution to 4000ppi, the speed and laser power settings of the CDI is adapted automatically.

It is recommended to use the default energy setting on all plates.



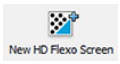
4. HD Flexo Screens in ColorPilot

HD Flexo Screens used to be an application of its own but has been moved over to Color Pilot since 23.07 to allow the usage of SaaS licenses.

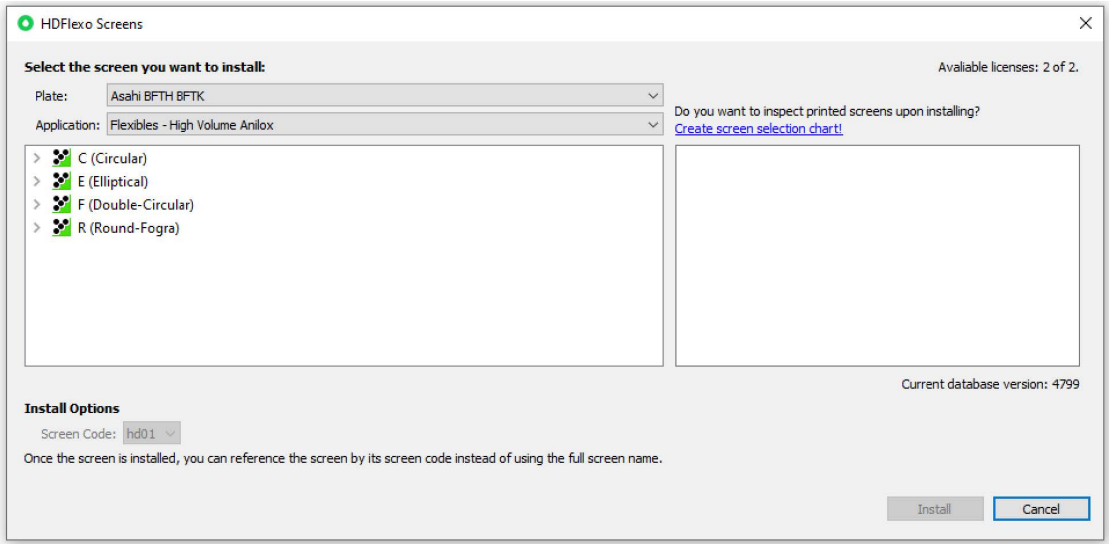
This means if you are in a SaaS environment, your licenses will be activated on the SaaS server, so local licenses are not required anymore.

If you are working with an on-premise Automation Engine Server, you will have your HD Flexo Screen licenses activated on the LAN which means you can still use the old application 'HD Flexo Screens Generator' (as it is still part of the Imaging Engine installation). So you basically have the choice; use Color Pilot or the standalone application 'HD Flexo Screens Generator'. Both have the exact same HD Flexo Screen database.

4.1. New HD Flexo Screen

The "New HD Flexo Screen" button 

gives access to the overview and installation of all available HD Flexo Screens. It shows available licenses for HD Flexo screens and also generates Targets (Len files) to test plates.



4.1.1. Plate definition

The plate database contains the pre-defined HD Flexo screening sets for all qualified plates. The database version is being shown on the right-hand side “Current database version:”. For each plate the screens are presented by print application, as different HD Flexo screen parameters might be needed to assure best possible quality depending on the printing conditions.

Each printing application contains a choice of HD Screens. These screens are typically used to compensate between light print conditions (e.g. narrow web) and heavy print conditions (e.g. wide web) and to optimize the ink density.

4.1.2. Screen naming

Each available screen is named with plate type, HD-Screen number, basic dot shape and if appropriate the shadow enhancement (microcell) option. These options are explained fully later in this document:

Examples:

- "DuPont DPR HD Flexo C36": Plate type is DuPont DPR, HD-Screen is 36, basic dot shape is "C" = circular.
- "DuPont DPR HD Flexo R46 MC12P": Plate type is DuPont DPR, HD-Screen is 46, basic dot shape is "R" = Round Fogra, with a "12P" microcell pattern

When installing the screen on the Rip, it gets a short-name "HD<number>", were "number" is a counter that shows the order of installation. The screen can then selected by using "HD<number>" (e.g. "HD01") instead of e.g. "C" = circular screening in applications like PackEdge and Artpro+.

4.1.3. License system

For each plate type one license is needed and every screen that belongs to the screening set of

this plate type can be used without consuming another license.

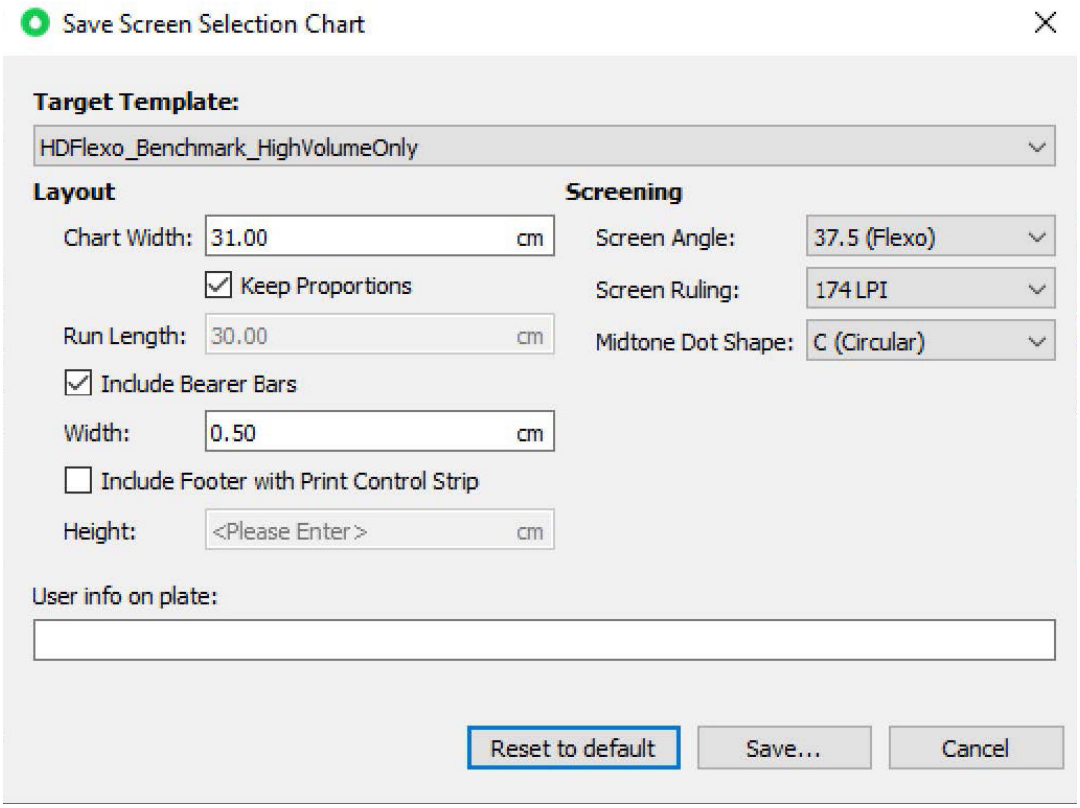
Examples:

- Using "DuPont DPR HD Flexo C30" out of the Label section and "DuPont DPR HD Flexo R56" out of the Flexible Packaging application section only requires one single license.
- But using "DuPont DPN HD Flexo C25" out of the Flexible Packaging section and "DuPont DPR HD Flexo C56" out of the Flexible Packaging section does consume two licenses.

The license counter on the top right side shows available and used licenses.

4.1.4. Target generation

The second function of the "HD Flexo screens installer" is to generate Len files containing targets for plate testing on customer sites.



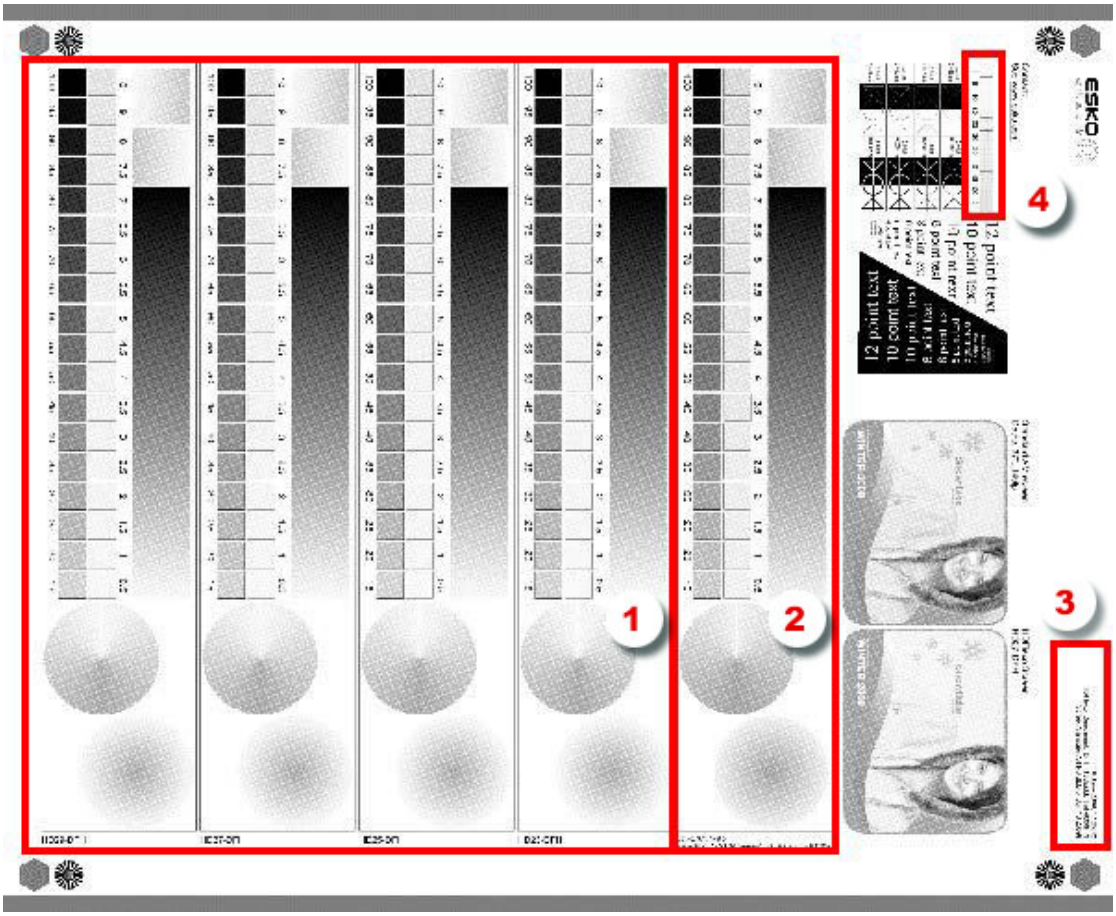
The target can be created for any plate found in the plate list even if no license is left. There are different type of targets available in the "Target Template" selection field.

4.1.5. The test chart for HD Screening

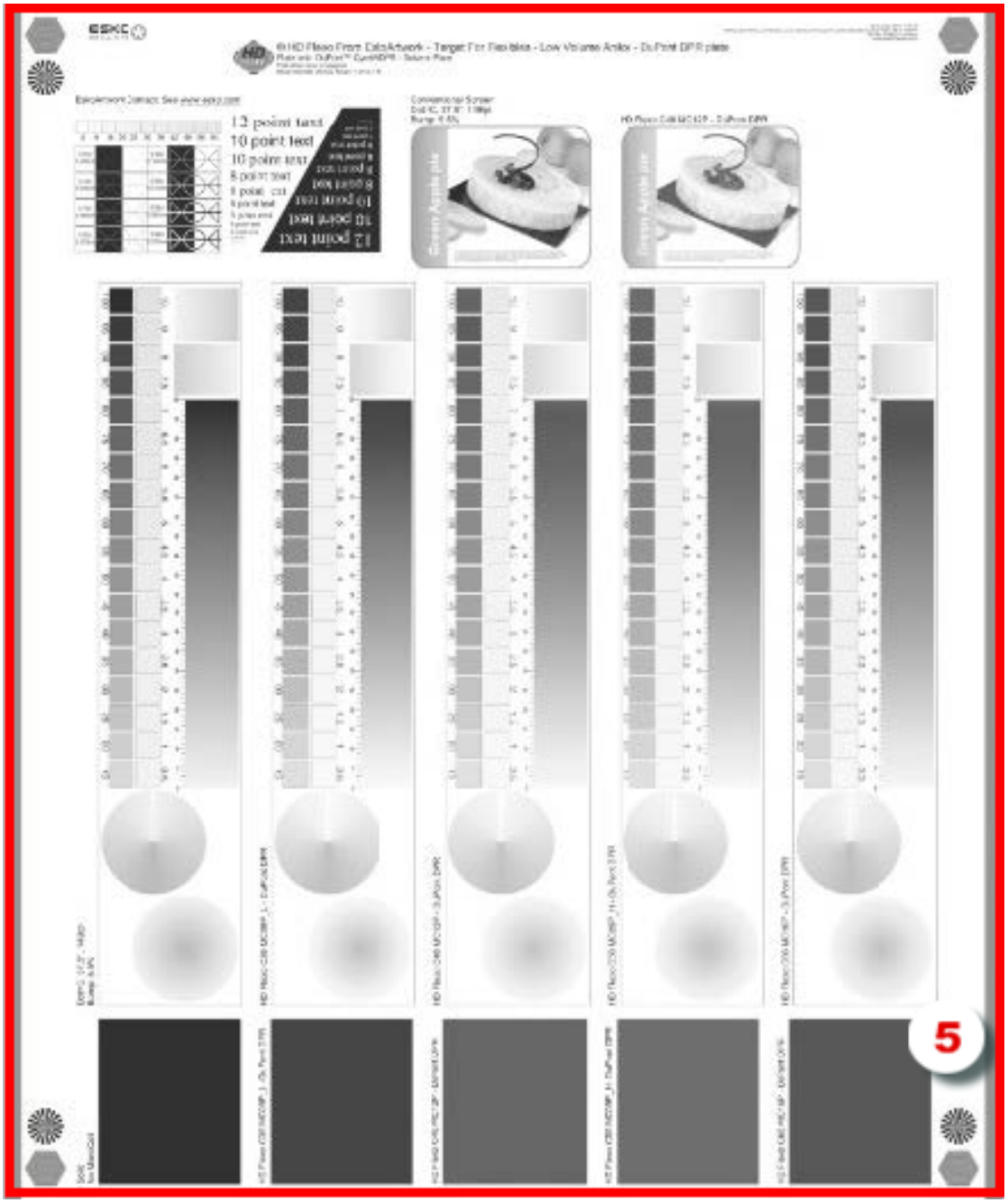
Test chart style

The basic test chart for testing HD Screening is available in horizontal style as shown below and also in vertical style as on the following page. Both styles contain the same basic elements so you can choose between them based on the press format. The vertical style contains additional elements for evaluation of microcells so is preferred in flexible packaging applications.

Horizontal style:



Vertical style:



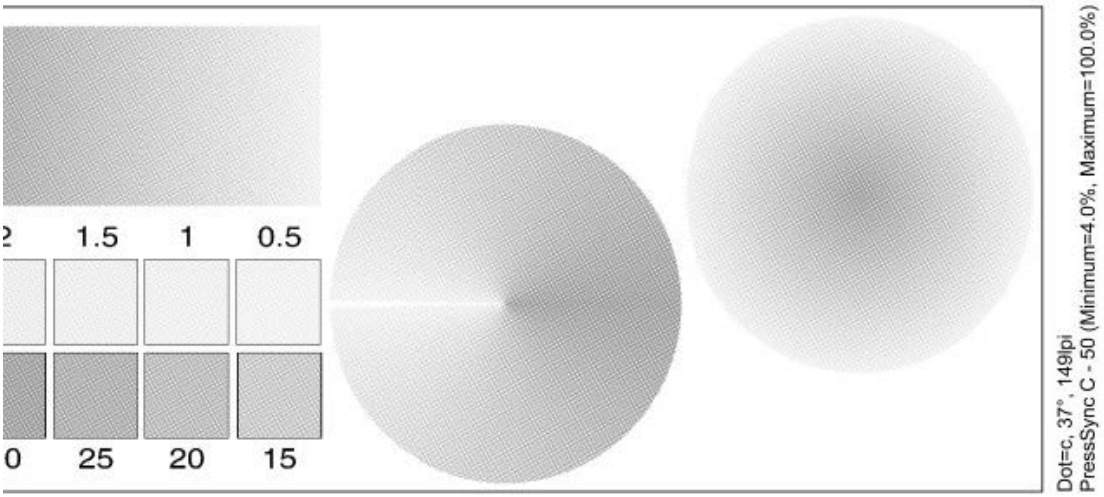
Elements of the test chart

The HD Flexo screens

The standard test chart consists of 4 different HD Flexo Screens and one conventional screen (round, circular, elliptical or double-circular).

The HD Flexo screens numbering tells you the number of pixel that are used to built the smallest dot.

Conventional screen

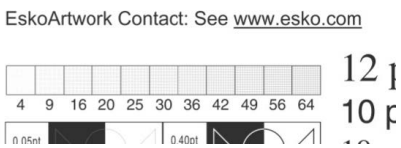


The conventional screen (Circular, Round Fogra, Elliptical or Double-Circular) is used to check plate-making quality and as a comparison tool.

File information

Shows Plate type, Resolution and Line count.

HIFI target

HIFI Target on HD Flexo Testform:	

The Hifi target consists of a technical pattern containg 4, 9, 16, 20, 25, 30,... pixels per dot with decreasing LPI. This target is equal for all test forms, independent from the LPI of the testform as well as from the plate type and application area.

The HIFI target is a means to control platemaking because in case of problems you can immediately see from a distance that the dot formation at this target is different from the expectation. For more details see *Dotsize measurement*

Solid (MicroCell) target

This consists of a set of five patches of solid (100%) tone. The reference patch contains the standard solid without MicroCell for comparison. The four other patches contain different MicroCell screen options. The HD screens above each patch are also screened with the same MicroCell structure.

By evaluating the quality of each MicroCell patch both visually for smoothness in the solid, smoothness in the shadow and mid-tone transition and also using a densitometer to find the highest solid density, the best microcell option can be chosen.

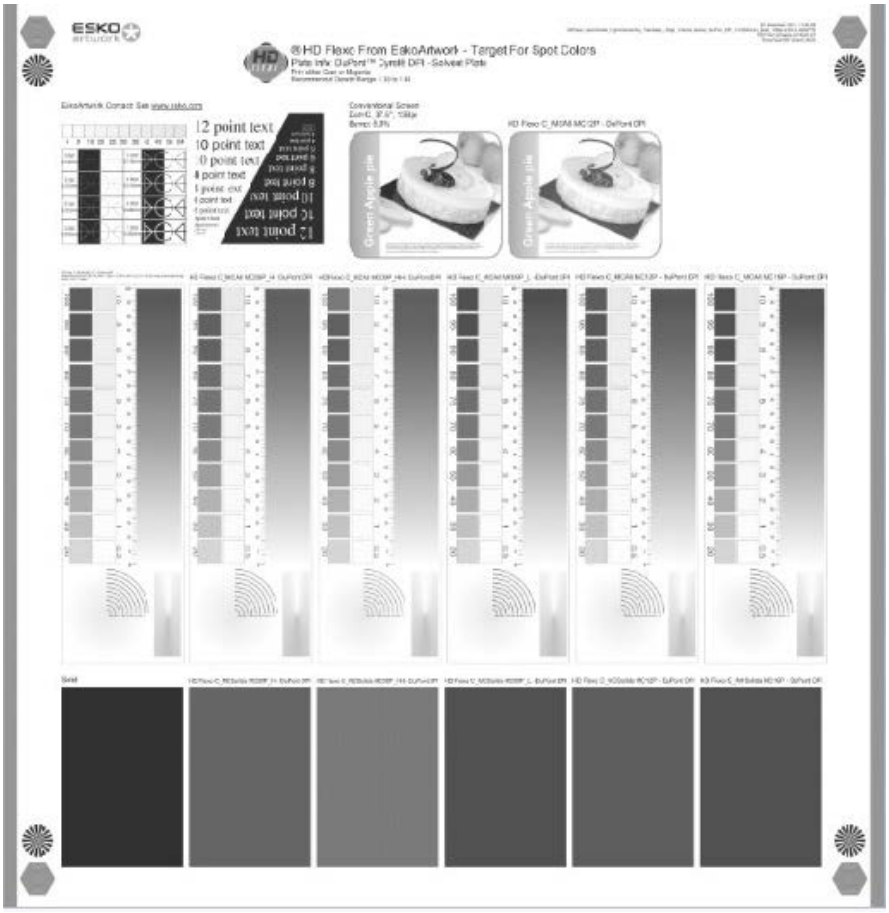
As the MicroCell structure is stopping before the HD screening starts in the highlights, the best MicroCell structure can be evaluated independently from the best HD screen.

This is later selected when installing the HD screen to be used in production.

Test chart for spot color printing

Alternative to the HD Screening test chart, a Spot Color test chart for printing of Spot colors or White overprint/underprint is available. It contains step wedges with standard screening each having different MicroCell structures to test ink transfer improvements (see *MicroCell screens* on page 35).

Evaluation should be done in the same way as HD Screening test chart.



4.2. HD Screens

Generally, HD Screens for Flexible Packaging are split into three sections: HD Screen for LowVolume (LV), Medium-Volume (MV) and High-Volume (HV) Anilox rollers. This split is necessary to ideally support the different Anilox systems that are in use for this application.

HD Screens for Labels only contain LV screens for the time being, as UV inks typically allowing much higher pigment densities and thus only require low volume Anilox rollers.

The HV application screens are most often used for spot colors and white underprints and these screens to not contain any highlight enhancement effect. The rest of this section discusses the LV and MV options. In process work a wide range of different Anilox configurations are used, but they can basically divided up into four different segments: High Anilox ruling with low cell volume, high Anilox ruling with medium cell volume, low Anilox ruling with low cell volume and low Anilox ruling with medium cell volume.

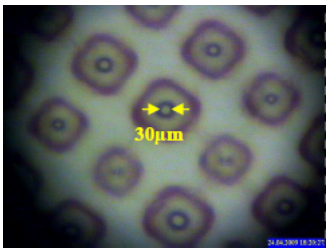
Small dots on the plate are inked significantly different depending to which segment the Anilox rollers on the press are belonging to. HD screens need to take this into account to always produce maximum quality on the press. However, the Flexo printing industry is clearly moving into the installation of High-ruling, low-volume Anilox rollers where the standard HD screens (LV) can be applied w/o any restrictions.

The basic guidelines for applying the different HD screens (LV, MV) can be taken from the table below:

Anilox Ruling Anilox Cell Volume	275–355 L/cm 700–900 LPI	355 L/cm–600 L/cm 900 LPI–1500 LPI
4.6 cm^3/m^2–7 cm^3/m^2 3 BCM/in^2–4.5 BCM/in^2	MV mandatory	MV recommended LV possible
1.5 cm^3/m^2–4.6 cm^3/m^2 1 BCM–3 BCM	MV recommended LV possible	MV possible LV recommended

A typical "dirty highlight printing" scenario with HD Flexo is that small dots are getting overinked by dipping into the Anilox cells. To minimize this risk, the largest dots in the HD screens must always be larger than the Anilox cells.

The largest dots in the HD screen below are about 30µm in diameter. This screen should only be used with Anilox rollers of 850lpi (330L/cm) or higher:



Anilox ruling:	700LPI 275L/cm	750LPI 295L/cm	800LPI 315L/cm	850LPI 330L/cm	900LPI 355L/cm	1000LPI 395L/cm
Anilox cell diameter:	37µm	34µm	32µm	31µm	28µm	25µm

The strength of the over-inking is determined by the Anilox cell volume: A lower cell volume typically is more forgiving for over-inking appearance than a higher cell volume.

On top of over-inking due to dipping into the Anilox cells, dirty printing can also be caused by an incorrect ink formulation. This can especially happen on solvent ink systems when the ink does not

contain the correct solvent balance (see *Ink formulation requirements* on page 40 for more details). Furthermore, dirty highlight printing can also be caused by too high impression settings between Anilox and plate (see *Impression between Anilox and plate* on page 40) or between plate and substrate (see *Impression between plate and substrate* on page 40).

The MV screens are more forgiving to over-inking of small dots in general, and thus are the most robust screens that are running well on all Anilox systems. However, especially on low volume Anilox systems, the highlight quality of the MV screens is clearly inferior to those achievable with the proper LV screens.

4.2.1. HD Screens for low volume Anilox rollers (LV)

Each certified flexo plate is supported with 4 different screens, whereas each of these screens has different minimum dot size settings (hereafter called "EP" = End point value, i.e. the number of pixels that create the largest dots in the highlight screens). As a higher number of pixels create more stable minimum dots, the rule of thumb is that heavier printing conditions require higher EP values.

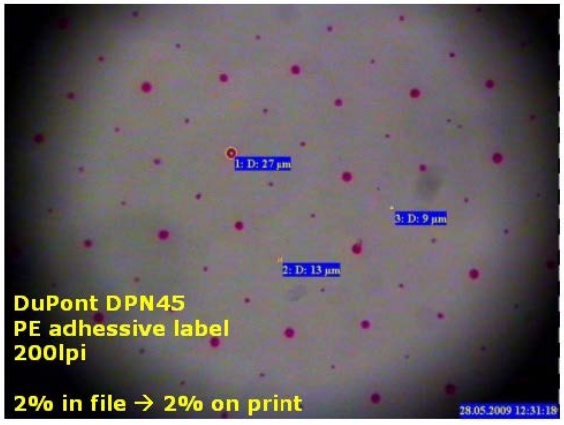
So the four screens available for each plate type are specifically created to cover all application situations in which this plate is typically used.

HD Flexo always assures that the 0.38% grey level creates printable dots on the processed plate.

The HD-Screens are generating modulated dot sizes in the extreme highlights, which creates smooth density impressions to the human eye.

At grey levels above 1% (depending on the plate type this can extend to 2% or even 3%), all dots in the grid are already printing in a well balanced mixture of larger and smaller dots:

Typical HD Flexo screen – at a grey level of 1% in the file, all dots are already contribute to the print in a well-balanced mixture of larger and smaller dots.



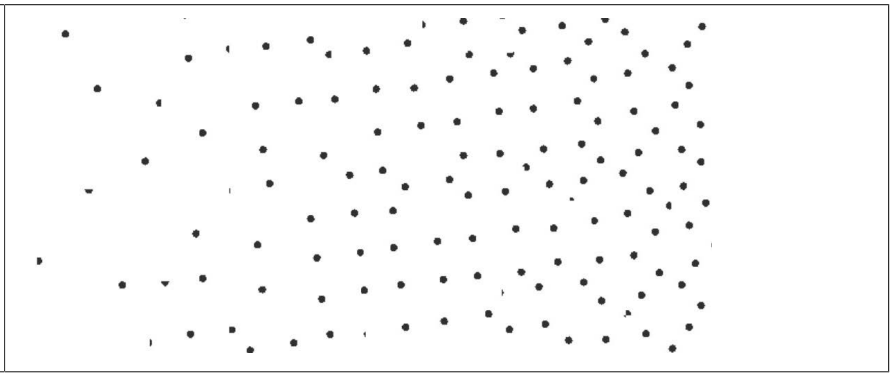
Although, for the reason of creating a smooth transition to zero at extreme highlights, the HD screens are engineered in such a way that the small dots are fading out at grey levels below 2% and thus only the large dots are printing.

4.2.2. HD Screens for medium volume Anilox rollers (MV)

MV screens are nearly equal to LV screen from about 5% and above (the exact value is depending on plate type and HD-Number as well as the screen ruling).

For lower percentages, the formation of very small dots is suppressed to avoid overinking on medium volume Anilox systems.

Instead, the number of dots is continuously reduced to realize transitions to zero.

Transition to zero with MV screens	

With MV screens, transitions to zero can be realized in a very robust way. The fading looks nice from a typical view distance (arm length distance), however it might show a visible graininess when looking at the printed result from a closer distance.

4.2.3. HD Screens for High Volume Anilox rollers

Often the ink transfer of spot colors (pantones) and white overprint/underprint requires very thick ink film lay down. Consequently, these inks are printed with highvolume Anilox rollers > 7 cm^3/m^2 (4.6 bcm).

There is a special HD Screening support available for this type of application as well, basically combining basic dots shapes (C, E, F and R) with MicroCell screening to improve the ink transfer lay down and ink film thickness.

See *MicroCell screening details* on page 42 for more details.

4.3. MicroCell screens

MicroCell screens are targeted to improve the ink transfer and ink lay down of solids and shadow screening dots.

The main application area is printing on flexible materials like LDPE, PE, OPP or PP by using solvent-based or water-based ink systems.

MicroCell screens can also improve the ink lay down on paper substrates when printing with water based inks.

MicroCell are applying a decent structure to the surface of digital flexo plates making this surface comparable to the surface of an Anilox ink transfer roller.

There are different cell structures available depending on the specific plate type, substrate and ink requirements.

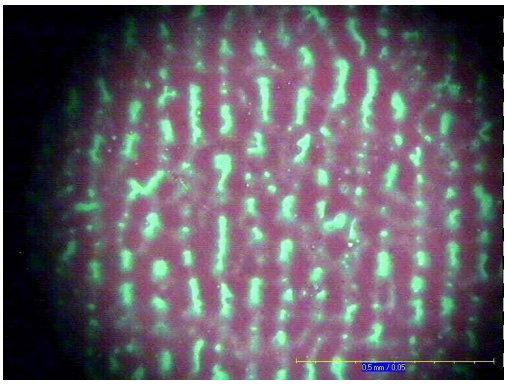
Each combination of plate type and printing application has a pre-defined default setting which is tested to give the best result under the most common usage conditions, and a choice of alternatives is also provided to deal with different usage conditions. The specific options available will vary depending on the plate type, and can easily be seen in the overview.

MicroCell screens can applied in combination with a highlight enhancement (LV or MV style as explained earlier) or without highlight enhancement using the High Volume (HV) screens.

4.3.1. Ink lay down with and without MicroCells

The ink lay down is typically influenced by the self-organization of the ink due to surface tension effects. This causes the ink film to tear into cells of about 100 micron in size, and the printing speed is often transforming these cells into lines oriented along the printing direction.

Typical pin holes pattern in the solids for a Flexible Packaging application is shown below:



This results in visible defects of the solids (so called „pin holes") that are reducing the flatness appearance of solids and overprints and especially also of pantone emulations. Furthermore they lead to a reduced solid ink density (SID) in general, making it often necessary to either

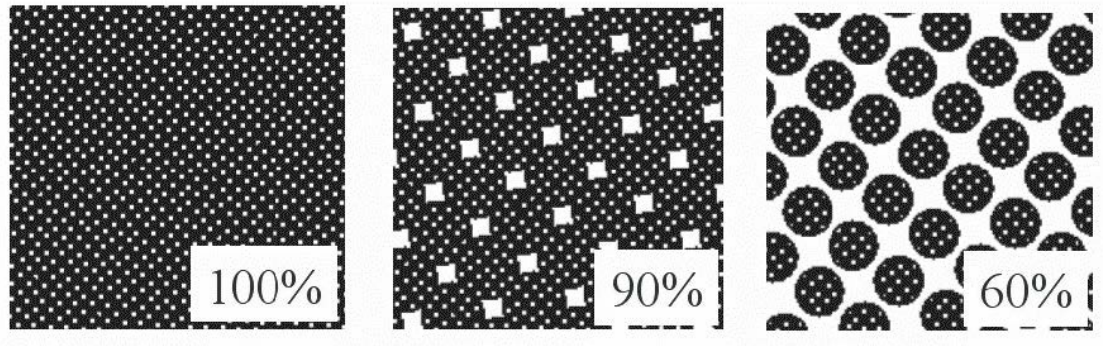
- separate linework and process work into two separate plates or
- use higher volume Anilox rollers to increase the solid appearance, but this is reducing the highlight quality.
- especially for underprints or overprints, the white is often printed twice to assure good opaqueness.

All in all, beside from the lower quality appearance to the human eye, all these technologies are meaning much higher cost to the printer.

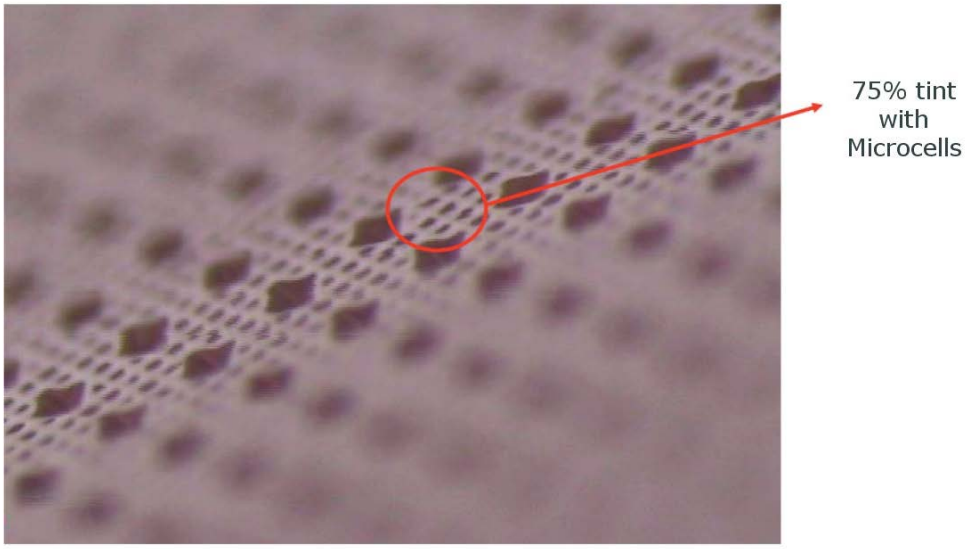
Contrary to all former technologies, HD MicroCell is generating the plate surface structuring not only in the highlights but also down the scale in the screening dots. This enables an ink lay down

improvement for the whole total tonal range starting from the mid-tones through shadows to solids, without generating transition steps in the tonal gradation.

Below are images of MicroCell structures in the LEN file at 100%, 90% and 60%:



Below is an image of the MicroCell surface structure on a processed DuPont DPR plate in a 75% tint.



The MicroCell structures have a protection distance to the edge of all screening dots, so that the original shape of the screening dots is not changed.

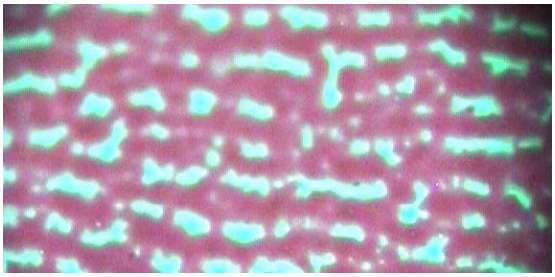
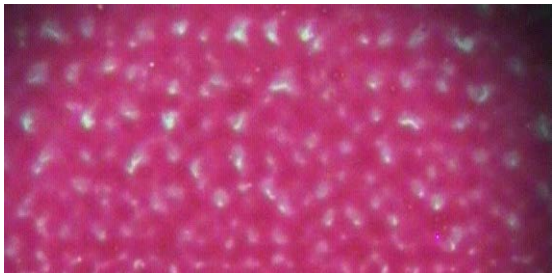
As the MicroCell structures around the – negative – shadow dots are guiding the ink flow around the dots, the shadow dots are not filling with ink during printing anymore. This results in a better linearity of the shadow tones and thus to a better shadow contrast in the print.

4.3.2. Solid ink density (SID) improvement

As HD MicroCell screens are eliminating the self-organization structures of the ink film, this technology significantly improve the solid ink appearance on the prints as well as the appearance and saturation of overprint colors.

By transferring more ink than a standard solid surface, the HD MicroCell technology can increase the solid ink density (SID) between +0.1 to +0.6, depending of application and printing process conditions.

As higher SID value also means higher ink consumption on the press (+0.01 has 25% more ink, +0.3 has 100% more ink), HD Flexo offers the best balance between SID increase and good solid appearance. This minimizes the ink consumption on the press in combination with smooth and pinhole free solids, thus improves sustainability and lowers overall printing cost.

Standard solid (no MicroCell)	Solid with MicroCell structures applied
SID= 1.3 	SID= 1.55 

4.3.3. MicroCell application guidelines

Besides of the type of MicroCell screening applied, the solid ink density on the print significantly depends on the following parameters:

Correct plate type usage

For the best overall quality, it is recommended to use a hard flexo plates in combination with HD Flexo LV or MV screens to optimize the highlight performance, and with MicroCell technology to improve the solid ink lay down.

This delivers excellent highlights with SID up to 1.6 (depending on Anilox and ink settings) and in combination with smooth transitions to zero.

To achieve the highest possible ink lay down, e.g. for special ink saturation requirements or for spot colors and white printing, it is recommended to use softer flexo plates in combination with HD Flexo MV screening and MicroCell technology. This delivers still decent highlights with very high SID values (up to 2.0, depending on Anilox and ink settings).

Correct mounting tape usage

Hard flexo plates:

Example plate types	DuPont DPR/DPI/DPU/DFQ/DFH, Flint ACE/FAB, MacDermid RAVE, Asahi DSH
HD screens to use:	LV screens for Anilox ruling >= 900lpi MV screens for < 900lpi
Tape recommendation:	Best choice: Medium firm tape eg Lohmann 5.3 or 3M 1020/1520

	(With medium soft tape eg Lohmann 5.2, the MicroCells will typically close the pinholes, but will not much increase SID. Very hard tape e.g. Lohmann 5.4 can increase SID by another +0.1 but makes highlights a little darker.
Highlight quality:	Very good highlights with nice transitions to zero.
Solid quality:	MicroCells are always reducing the pin hole pattern Average SID increase with Microcell +0,1...+0,2 Typical solid ink densities: • D=1.6 on Anilox with cell volume 4.0cm^3 (2.7bcm) • D=1.4 on Anilox with cell volume 1.8cm^3 (1.2bcm)

Soft flexo plates:

Example plate types	DuPont DS2/DPL/DFS/DFM, Flint ACT, MacDermid DMAX, Asahi DSF
HD screens to use:	Use MV screens for print trials, because they are robust under all conditions. If there is lots of time for testing and the anilox is 900 lpi or more, you can also try LV screens
Tape recommendation:	Best choice: medium soft tape eg Lohmann 5.2 or 3M 1920/1320. Medium hard tapes (e.g. Lohmann 5.3, 3M-1020/1520) may further increase SID, but this can introduce a slur effect especially in the quartertones. For spot colors, medium hard to firm tapes are always recommended
Highlight quality:	Transitions to zero are not easy to achieve as these plates are very soft, therefore a "min dot repro" should be used to prevent long transitions to zero. Short transitions to zero can be realized.
Solid quality:	Typically +0.1 ... +0.2 better than hard flexo plates. Microcell improves by +0.1...+0.6 further depending on the printing conditions and Anilox specs (highest SID recorded so far was 2.3)

Impression between Anilox and plate

The printer should make sure that this parameter is set up properly. Too low impression will under-ink the plate thus the MicroCell structures cannot work to their full extent.

Contrary to this, a too high impression setting will over-ink the plate and will press ink down to the floor of the plate. This results in dirty highlight printing and inkbuildup in the quarter and mid-tones, which often only becomes apparent after having printed a few thousand meters.

Impression between plate and substrate

As long as the impression is high enough, this parameter does neither significantly influence the printout behavior of solids nor of the HD screens.

If the impression is set too low, then breakouts in solids can be observed. So the impression between plate and substrate should be gradually increased starting from kiss print until all the solids are printing out homogeneously.

Doctor blade

The doctor blade is also having a big influence on the quality of the ink transfer. The doctor blade is used to clean the Anilox from excessive ink before it gets in contact with the printing plate. The doctor blade is a consumable that is eroded by an abrasion process caused by the ink pigments.

In case the doctor blade is worn off, irregular stripes in print direction can be detected especially in solids and plain screened areas.

If case the doctor blade is improperly mounted, e.g. bended, uneven ink transfer over leftmiddle- right can occur.

Ink formulation requirements

MicroCells are increasing the ink transfer capability of the plate surface of solids and screening dots.

This does only lead to an increased solid ink density and improved smoothness of the ink lay down when the ink can be properly transferred from the plate to the substrate.

The ink transfer capability of solvent based inks significantly depends on the solvent mix inside the ink. As there are over 1000 different brands/types of flexo printing inks available worldwide, we can only comment on necessities for the most commonly used NC inks (inks based on nitro-cellulose binder). Most of these inks contain the following components:

Pigments

Pigments create the color component of the ink and are carried by the solvent mixture.

Ethylene (alcohol) to adjust the ink viscosity

The ink suppliers are typically delivering an ink which is far too thick for printing (40s-50s). Before using this ink on the press, it must be made thinner by adding Ethylene.

Target viscosity in most cases is 22s-24s, but there are special inks available that can be printed at 28s-32s for increased ink transfer.

Retarder (Ethoxypropanol) to adjust drying behavior of the ink

More retarder lets the ink dry slower. This is needed e.g. when printing very small highlights to make sure that the ink is not drying before the inked dot is delivering the ink to the substrate. Also sometimes this is helping to reduce pin hole in the solids. Too much retarder can lead to ink splashing, thus should be avoided.

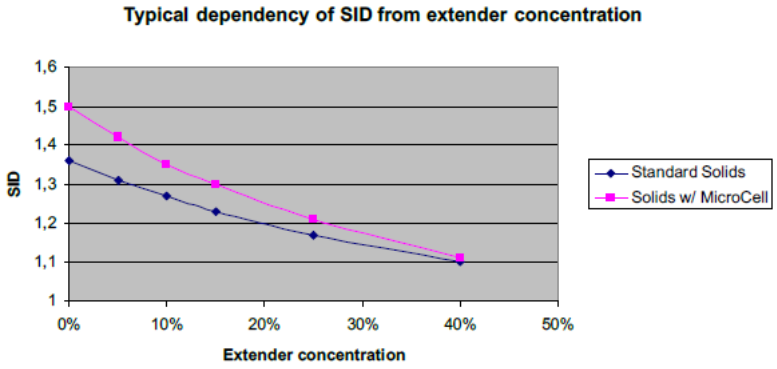
Retarder is basically also reducing the ink viscosity, very similar to Ethylene.

Extender to reduce pigment density

Extender is added in case the solid ink density (SID) must be reduced to match color targets. Extender basically is ink w/o any pigments.

In some cases, the solid ink laydown improvement with MicroCell depends from the level of extender in the ink.

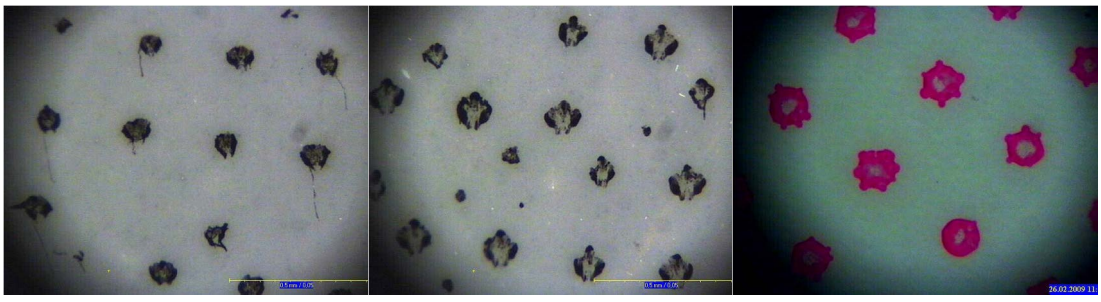
Please do not take over the extender concentration which has been determined for standard solid printing, as this might change with MicroCell! It is recommended to start a press test w/o any extender in the ink, to first determine the optimum ink laydown. Then gradually add extender until the target SID has been reached.

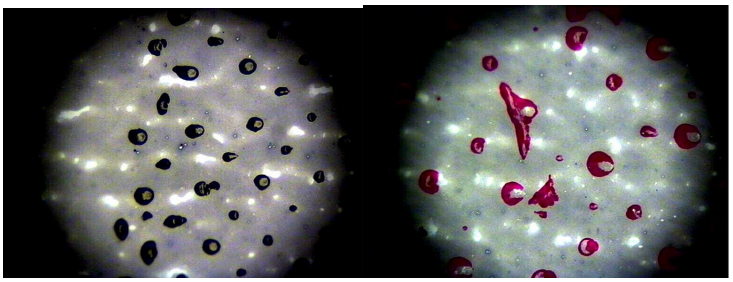


Additives

Additives are needed to cure special ink transfer problems, e.g. when the ink is too sticky or when the ink is not properly taken/delivered by the printing plate.

Table:

Print defects that can be cured with additives (please contact the ink supplier how to cure these effects):


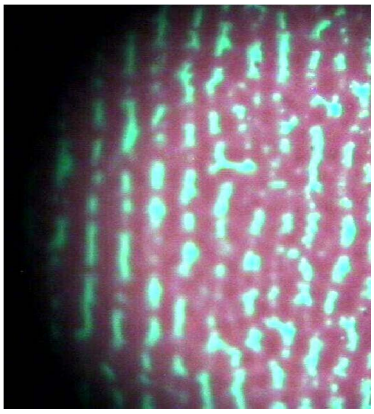
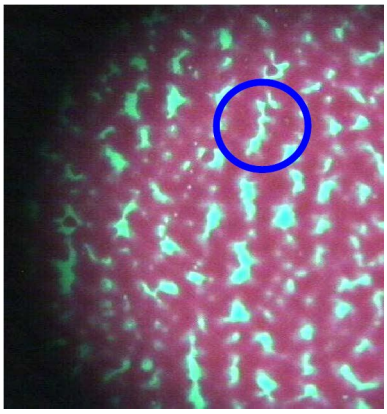
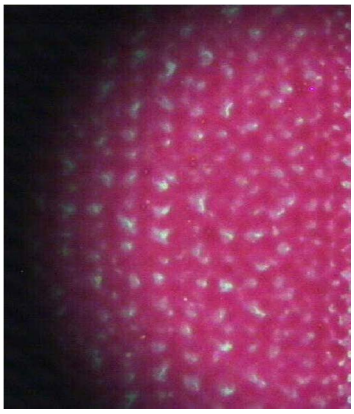


All additives should only be used with care!

For NC inks, an important additive is Acetate (Esther) which is needed to improve solid ink laydown. If Acetate is missing, MicroCells might not work properly. Acetate is evaporating much faster than alcohol, and when the acetate level becomes too low (e.g. after a press duty cycle) this might result in severe printing defects. This can even happen if the press is equipped with an automatic viscosity control system, as in most cases these systems only add alcohols to keep the viscosity constant.

But often the acetate level is not taken care of. A too low acetate level can often be detected by the microscopic appearance of the solid ("fractal" pinhole pattern like the one marked with the blue circle below). To cure this situation, it is often enough to add a few percent acetate to the ink (2%-5%).

The Acetate level should not be higher than 10% as this might lead to plate swelling.

Standard solid (no MicroCell)	Solid with MicroCell but too low acetate level	Solid with MicroCell and correct acetate level
		
SID = 1.3	SID = 1.35	SID = 1.55

Cleaning of MicroCell flexo plates

The cell structures are designed in such a way that all plates having the MicroCell technology applied can be handled and cleaned in the same way than all other HD Flexo plates.

MicroCell screening details

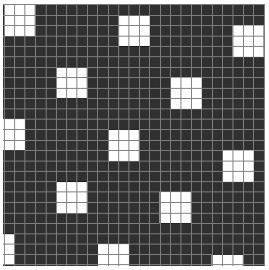
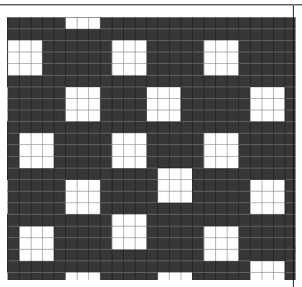
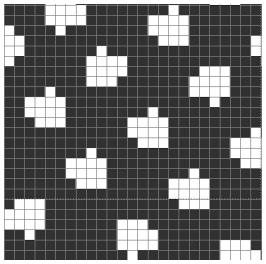
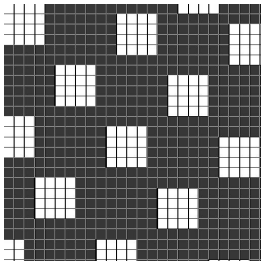
There are various types of MicroCell screening available to match different application environments.

As Microcells are especially designed for ink transfer improvement in Flexible Packaging printing, MCs can be combined with any screen out of the Flexible Packaging section.

MicroCells for low and medium volume Anilox rollers

There are four Microcell pattern predefined for each plate type in the sections “Low volume anilox” and “Medium volume anilox”.

These patterns have different values for cell size and repetition ruling, and cover the majority of all application cases:

			
MC_9P_L	MC_9P_H	MC_12P	MC_16P

The MC_12P is the default pattern which covers the most variety of different Anilox and ink parameters. The 9P patterns are especially suitable for very low volume Anilox rollers (< 4 cm^3/m^2 or 2,4 bcm). The 16P pattern is best suitable for good ink transfer on higher volume Anilox rollers.

For some plate types (e.g. DuPont DPN and Flint FAB), the MC_16P is replaced by a very high frequent structure with smaller cells, as these plate types are capable of holding finer negative details.

MicroCells for Spot color printing

As spot color and white transfer typically is done with Anilox roller of quite low ruling but very high volume, there is a dedicated section available for “High Volume Anilox”. The MicroCell structures can be combined with standard screening (e.g. C-, R-, E-, F-shape).

It is possible to choose whether the microcell should be applied throughout the tonal range (MCAll category) or whether it should be applied to the 100% solid tones only (MCSolids). When the screen will be used to print tone work, the MCAll option is typically used to avoid a noticeable tonal jump between the shadow and solid tones. Many applications in this area of course involve the printing of solid line art only.

5. Print guidelines and print quality evaluation

5.1. Plate mounting

The right plate mounting tape is essential to achieve an optimum print quality. The wrong tape can lead to a series of printing defects:

- too low solid ink transfer (low ink density, too many pinholes)
- squeezed highlight dots
- press bouncing (vibrations leading to alternating lighter to heavier printing in circumference direction)
- non-equal impression settings in axial direction.

Due to the complexity of the printing process, only some general rules of thumb can be given in this document.

If the rules of thumb are not sufficient to solve a printing quality problem, it is advised to test a series of tapes from different suppliers until an improved result can be achieved.

Softer and harder plates – Shore-A hardness

- Plates can be softer or harder
- Softer plates have better solids, but often poor highlights (small dots are easily squeezed on press)
- Harder plates have very good highlights (small, stable dots), but typically poor solids (sometimes structured due to irregular ink transfer)
- Plate hardness is measured in °Shore-A

Tape guidelines

Rules of thumb:

- Use harder tapes to improve solids, use softer tapes to improve highlights
- Use a tape that is as hard as possible for best combination of good solid ink density and good highlight printing (and that still avoids bouncing)
- For combination of solids and screens:
  - hard plates should be mounted with medium-hard tapes
  - softer plates should be mounted with medium-soft tapes
- Plates containing only solids and linework (no screens) should always be mounted with hard tapes (e.g. for spot color or white printing)
- When you are facing bouncing on the press, this often can be reduced by softer tape (especially on wide-web presses)
- Paper adhesive label stock requires softer tapes to prevent mottling
- Never re-use tape for high quality prints (although most printers do so)

Typical tapes

Soft: Lohmann 5.1, Tesa Yellow, 3M 1220

Medium Soft: Lohmann 5.2, Tesa Red, 3M 1920/1320, Rogers 3120

Medium hard: Lohmann 5.3, Tesa Pink, 3M 1020/1520, Rogers 3320

Hard: Lohmann 5.4, Tesa Blue, 3M 1720/1820, Rogers 3520

5.2. Print setup for benchmark tests

When running tests or benchmarks for print evaluation, it is mandatory that the press is operated with exactly the same parameter set (impression settings, ink system, Anilox system, press speed etc.) that will be typically used for commercial jobs.

To avoid bouncing, make sure that the test form is made according to the circumference and printing width of the press and that the bearer bars are running in circumference direction of the sleeve (this is more important for wide web presses than e.g. for label presses). Please also inspect for other press problems (insufficient ink transfer etc.).

Please also make sure that impression settings are kept equal left – right.

5.3. Print quality evaluation

The evaluation of the 1-color HD Flexo test form should be made according to the following criteria in order to select the best suitable screen:

Smooth transitions to zero

All vignettes (circular as well as linear ones) should show a smooth transition to zero without visible edges or halo effects at the end.

Graininess of extreme highlights

The extreme highlights should not show grainy structures.

In case the graininess is too high, it is recommended to use a bump-up to cut off the grainy grey levels.

Achievable minimum highlight density

The minimum highlight density should be inspected visually and with a spectrometer measurement device.

The minimum highlight density should be at least 40% below the 0.5% field with circular screening.

Linearity of highlights

When measuring the highlight test fields (0.5%, 1%, 1.5%, ...), the print density should increase linearly.

Note: Make sure that there is no press bouncing, as this might lead to alternative increase and decrease of print densities.

Note: Check for equal impression left-right, otherwise highlight results can be misleading.

6. Repro Guidelines

Selection of HD screens

The selection of the proper HD screen should always be made based on the print evaluation of an HD Flexo 1-color test form. HD Screens are delivered according to print application area, for example Labels, Folding Carton or Flexible packaging. For best results, start with the 1- color test form for the appropriate application and choose the screen from there.

As a rule of thumb, wider web applications, higher relief thickness as well as lower LPI are requiring a higher EP setting to maintain stability on press. Heavier print conditions (impression, friction) also typically need a higher EP setting.

HD Screens should be selected in order to create homogeneous grey levels to the human eye in the highlights. Visible graininess should be avoided as far as possible.

Controlling the extreme highlights

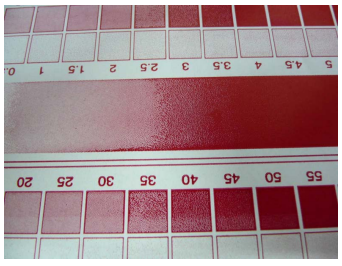
HD screens are designed to achieve the best possible printing quality of extreme highlights. Nevertheless, the specific characteristics of HD screening need to be taken into account to assure a high-end highlight print result.

The most disturbing effects in highlight printing are

- Improper Anilox/ink system
- Over-impression on the press
- Grainy appearance of highlights
- Mottling on uneven substrates

6.1. Anilox/ink system

The ink system on the press should be capable of transferring small droplets of ink, otherwise highlight areas will become too dark or other printing defects may be visible:

 Circular vignette	 Circular vignette	
Anilox LPI suitable for job LPI settings	The outer area of the vignette is printing with a darker halo: Anilox LPI critical low or	Anilox LPI too low or ink volume too high for job LPI (ink transfer defects in mid-tones or Anilox

	impression settings too high (compensation by additional bump-up possible). It is recommended to use MV screens instead of LV screens.	moiré visible, can only be solved by reducing job LPI or increasing Anilox LPI). As the mid-tones are affected, this cannot be solved by using MV screens either!

The job LPI should always be selected to match the Anilox settings on the press.

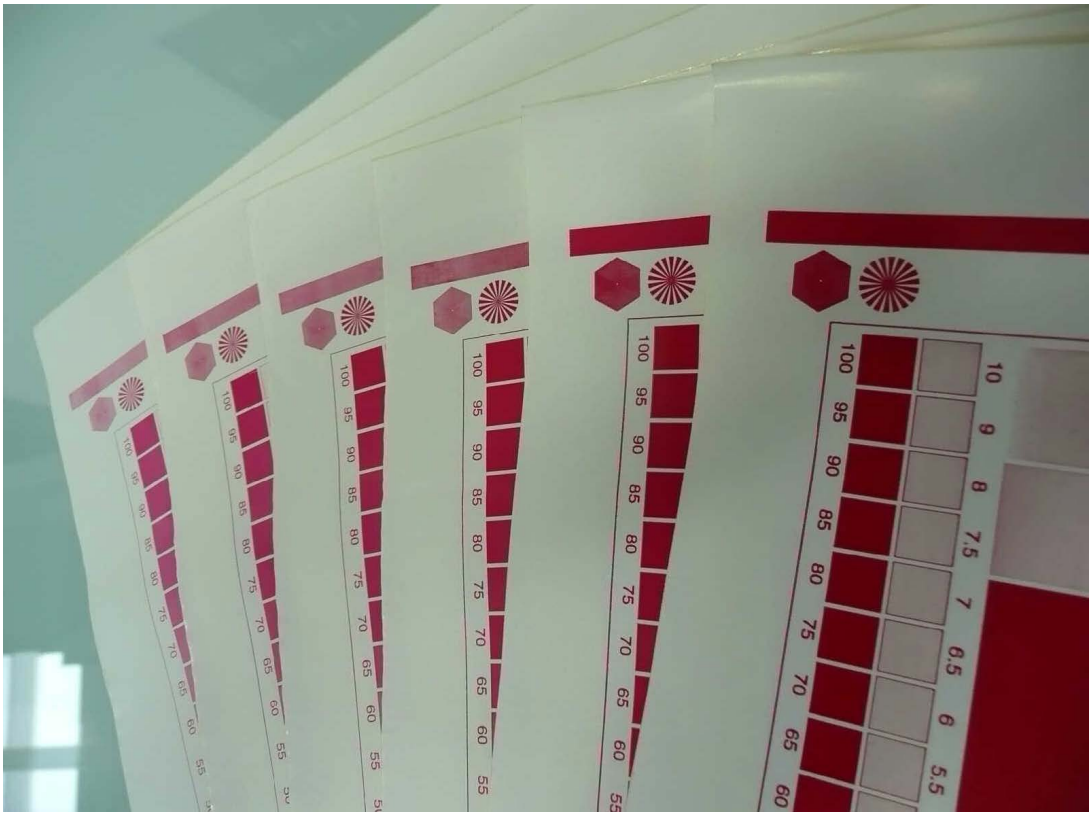
As a rule of thumb, the Anilox LPI should always be at least 6 times higher than the job LPI to assure a good ink transfer on extreme highlights.

Examples:

- 133lpi (52 L/cm) screen: Anilox >800lpi (320 L/cm)
- 150lpi (60 L/cm) screen: Anilox >900lpi (360 L/cm)
- 175lpi (70 L/cm) screen: Anilox >1050lpi (420 L/cm)
- 200lpi (80 L/cm) screen: Anilox >1200lpi (480 L/cm)

In general, UV inks systems (Label printing) are often capable of delivering very good results with lower Anilox settings as well (e.g. 200lpi in the job might only require 400 L/cm Anilox settings for Offset like print quality). But this always needs to be tested as too many press specific parameters are involved.

When increasing the Anilox LPI, this is typically accompanied by decreased Anilox cell volumes and thus lower solid ink densities. This needs to be taken into consideration for the color management, although this decrease in solid ink density can be compensated to some extend by using the MicroCell technology (see *MicroCell screens* on page 35).



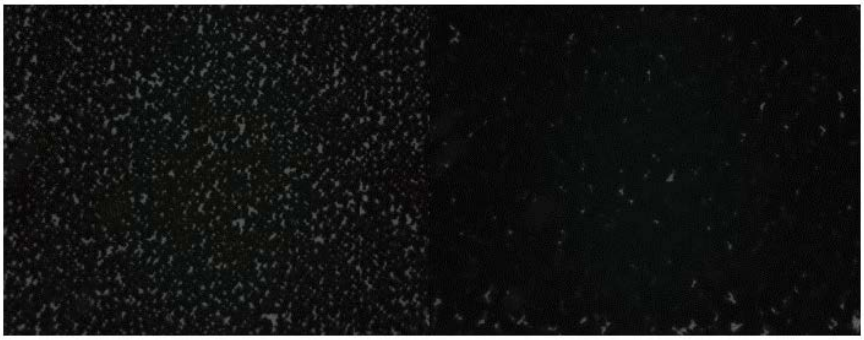
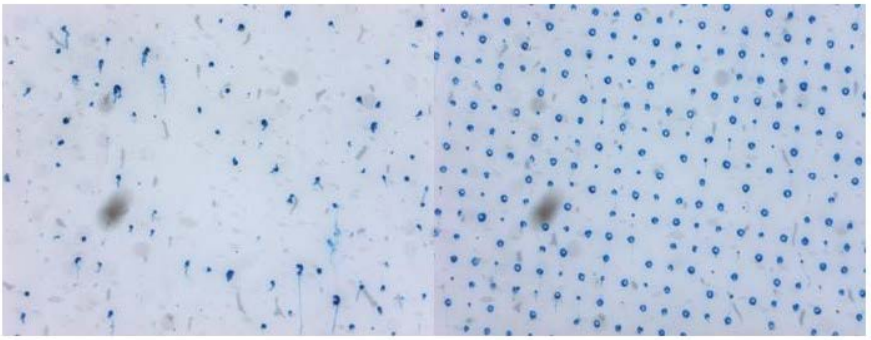
Visual change in solid ink density in dependency from Anilox LPI (left: 1200LPI -> lighter solids, right: 320LPI -> darker solids)

If it is not possible to adapt the Anilox LPI to the job LPI, a bump-up should be used to eliminated the extreme highlights from the job and thus to assure a proper print result. But the bump mechanism can only be used as long as the ink transfer in the quarter-, mid- and three quarter- tones is still good enough.

Furthermore, using a bump up will always reduce or even eliminate the possibility to print transitions to zero without a visible edge at the end of the vignette.

It is also important to take the quality of the Anilox roller into account. The cell volume of older Anilox rollers is often significantly reduced compared to a new roller. This typically happens either due to ink deposition in the bottom of the cells that cannot be cleaned anymore, or due to erosion of the cell walls.

The printing specifications of those "worn-out" Anilox rollers can significantly vary from the results achievable with new Anilox rollers.

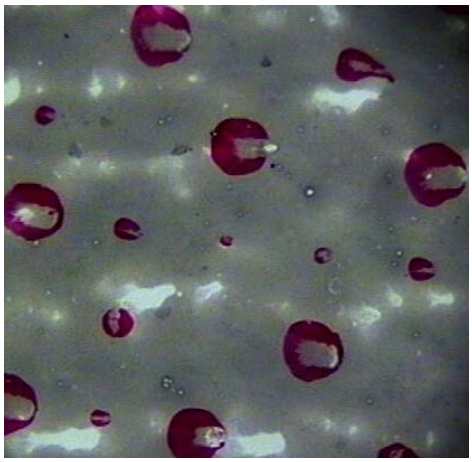
Solids	 Worn-out Anilox, SID=1.27 New (same specs), SID=1.91
Highlights:	 Worn-out Anilox, 2 % screen New (same specs), 2 % screen

Also the doctor blade can have a negative impact on the highlight print quality. A worn-off, bended or damaged doctor blade can lead to improper inking of dots especially at the edge of transitions, which can be lead to very similar structures to overimpression of overinking effects.

6.2. Over-impression on the press

Often printers are over-squeezing a plate to improve the ink transfer in the solids. Although HD screens are specifically designed to increase the stability of small dots, an over-impression always reduces the possible highlight print quality.

A typical sign for over-impression is that a "needle structure" can be seen in the highlight dots as shown below:

Typical over-impression pattern on microscopic scale – the bended dot is clearly visible as white "needle" with too much ink around it.	
Typical over-impression pattern on macroscopic scale: Strong graininess.	

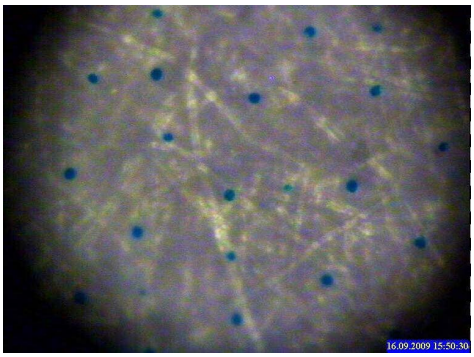
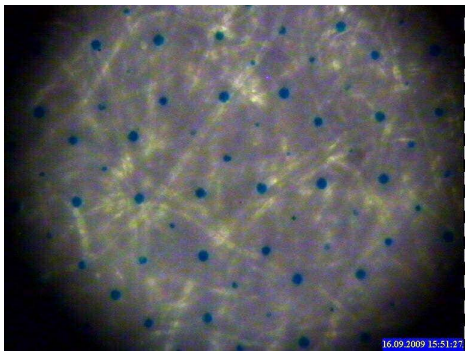
In many cases, over-impression can be reduced by using the right plate mounting tape that is increasing the solid ink density. The printer then can reduce impression settings to improve the highlights.

In other cases a change of plate type can solve this problem.

6.3. Avoid grainy appearance of the extreme highlights

The most visible graininess is created in case the design contains extended areas with flat grey levels below 2%. As the HD screens are not printing with the full number of dots for grey levels below approx. 2%, an effective reduction of the job LPI is generated that might increases the visibility of the stochastic to the human eye.

In case the graininess is getting too visible, the corresponding areas in the CT image should be slightly bumped up to a level where the HD screen is just printing with the full number of dots (see pictures below).

	
Extreme highlights with HD screening: • Needed to smooth transitions to zero • Should not be used within extended flat tone areas to avoid grainy appearance, especially in case of over-impression	Lower highlights with HD screening (>2%): • No visible graininess within extended flat tone areas

6.4. Smooth vignettes to zero

Short vignettes to zero are always smoothened by HD Flexo screens at the end. This is especially true when objects are just placed on top of an empty background.

It is mandatory that technical vignettes to zero are ending at 0.78% rather than running all the way down to 0%. This is because the RIP is mixing grey level 0%, 0.38%-0.78% which causes 0%-holes at the vignette end. These holes are destroying the self-supporting structure of the HD Flexo screening dots and are leading to dirty printing at the end of vignettes:

	
Vignette ending at 0%: • holes in the screens below 0.78% • dirty printing at vignette end	Vignette ending at 0.78%: • no holes in the screens • smooth printing to zero

Short vignettes to zero are even working well in case a bump-up is applied to the HDScreen, as long as the minimum tonal value is still showing a dot-size mix. Long vignettes to zero, e.g. over the whole background of the job, will only run out smooth in case the bump-up is not too high. It is essential that the first few grey values in the file are producing a visible stochastic like illustrated in the above left figure.

If it is not possible to print these low grey levels without squeezing due to very heavy printing conditions, it is recommended to reduce the line count just for this long vignette to a value where the bump-up becomes reasonable low.

6.5. Images

Digital noise should be eliminated from images by using Esko Artwork FlexoTools (clean below 0.78%)

6.6. Mottling and fluting

Mottling is an effect that might become visible in case of uneven substrates.

Mottling can have various appearances:

- Structures in dot closure area (bridging issues):

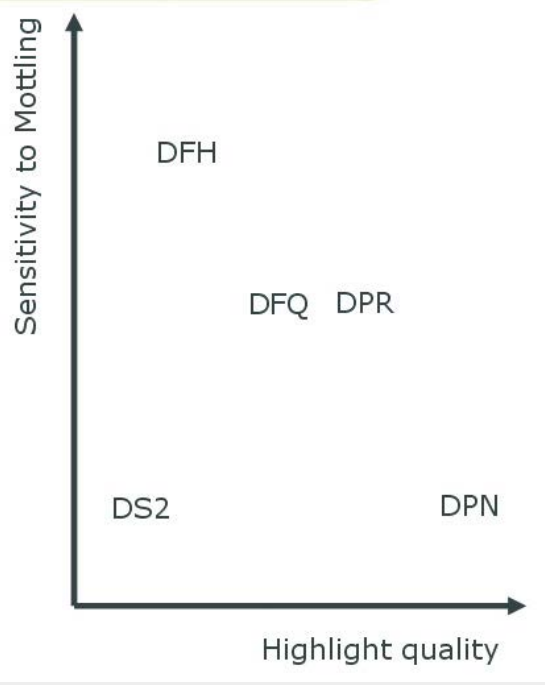
  - Become significantly less visible with 4000ppi
  - Curable with different dot shape (Round-Fogra (R) or Double-Circular (F) dot, the R dots can be used in combination with offset angles to further reduce mottling)
- Fluting in corrugated:
  - Prints darker on flute than beneath flute
  - Can be cured by correct plate/tape/foam sandwich
- Mottling on adhesive label or paper stock (UV ink):
  - Typical in full range 25% - 70%, sometimes also visible in shadows and solids
  - Variation in substrate thickness changes the local ink transfer, leading to lighter and darker areas.
  - In this case the usage of R-Dots together with offset angles are recommended. The mottling effect can be further reduced by using softer plates (e.g. DuPont DPN instead of DuPont DPR) or using a different mounting tape.
- Mottling on paper stock (solvent ink):
  - Very similar to mottling on adhesive label stock, same methods can be used to minimize this effect.
  - On top of that, often the usage of MicroCell screens is significantly reducing the mottling effect thus solids and shadows are looking much smoother

Important:

Never use Offset angles in combination with circular screening on paper stock – this can lead to a high-frequency overprint moiré in the mid-tones.

Although this can be a valid combination for other applications (e.g. aluminum printing).

The graph below gives some indication about mottling sensitivity of some DuPont plates in comparison to the achievable highlight quality:

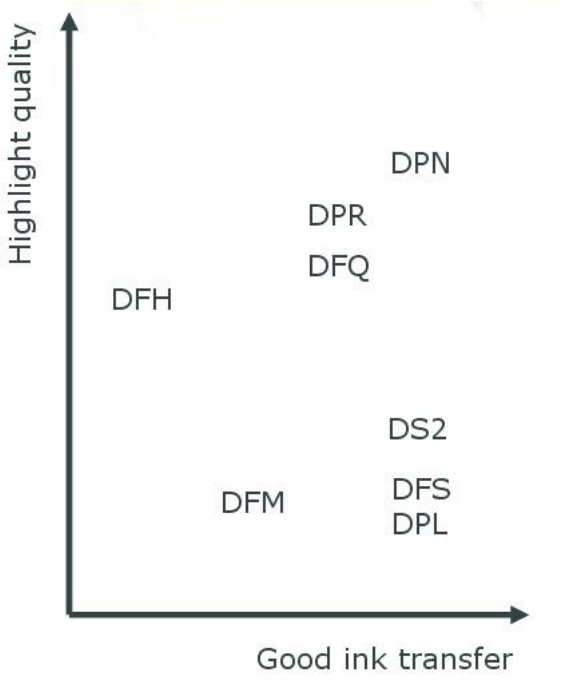


7. HD Flexo Plate Application Specifications

This chapter gives a detail definition of the application scenarios of all so far characterized digital flexo plates.

Quality range of certified plates

Not all HD Flexo certified plates are delivering the same quality on press, the figure below illustrates the quality vs. ink transfer capabilities for some DuPont plates:



Perfect transitions to zero are only achievable when using HD Flexo in combination with high quality level plates.

However, the highlight quality for all other plates can always be significantly improved by using HD Flexo. As a rule of thumb, the minimum achievable highlight density can be at least cut in half compared to circular screening made with 2540ppi imaging.

8. QA for HD Flexo Plate-making

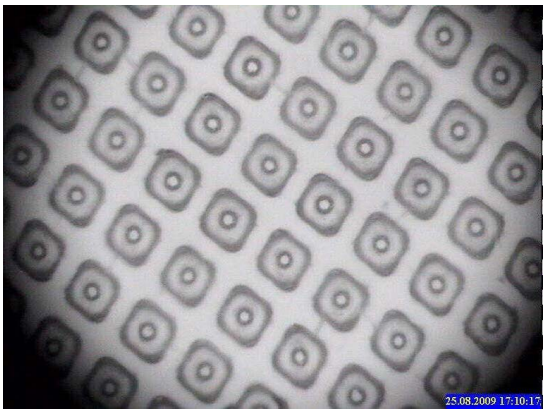
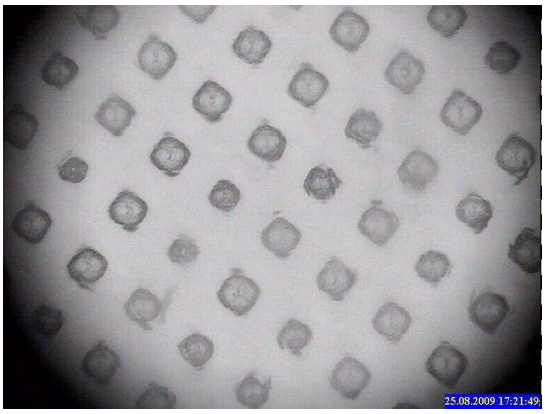
8.1. Imaging quality

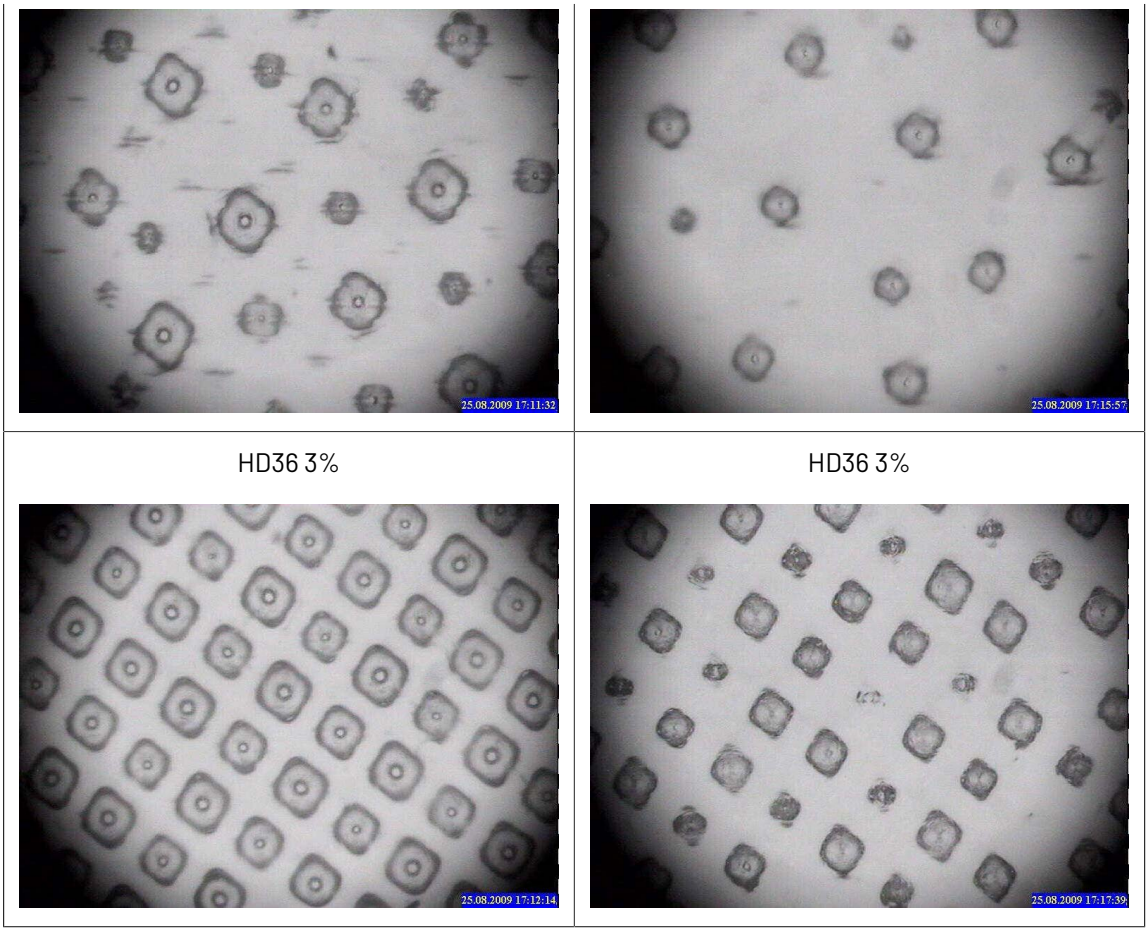
Check the engraving Quality as stated in the CDI Acceptance test section C "Imaging quality check".

8.2. How to check an HD Flexo plate

1. **Target generation**: Generate a target for the desired plate and linecount. The HD Flexo Screen Installer shouldbe used to do that.
2. **Platemaking**: Image the plate and process it with the usual processing parameters.
3.
4. **Judge the plate**: Put the plate upside down on a light table and look at the circular 0.5% field with a 100x microscope. Remember that the circular is bumped by default.

   Examples with a DPI45 at 150lpi:

Good reference plate	Plate with processing problems
Circular 0.5%	Circular 0.5%
	
HD36 0.5%	HD36 0.5%



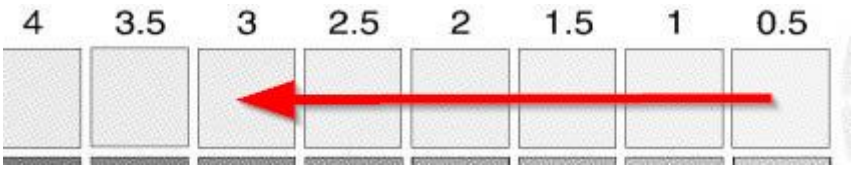
Case 1: Good result:

The 0.5% field looks similar to the reference plate. Meaning a solid top. All dots the same size. If you touch this area with your fingertips it should have the same height as the surrounding solid elements.

This plate is ready to print to finally pick the right screen.

Case 2: Insufficient result

The 0.5 dots are much too small or gone - like in the right column. The height is lower then the surrounding elements (use the touch test).



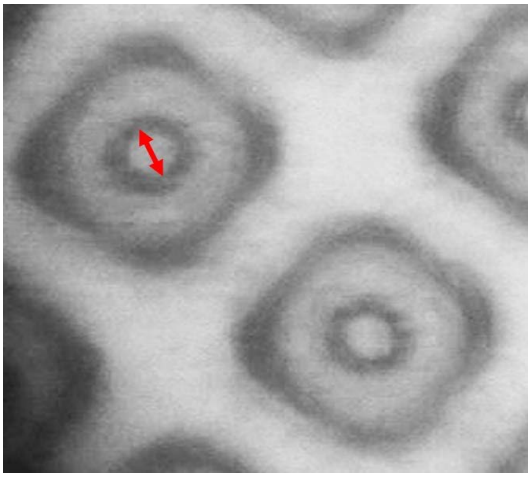
If you can not produce a usable plate, please get in contact with the plate supplier or Esko support.

8.3. Measuring dotsize and relief depth

Dotsize

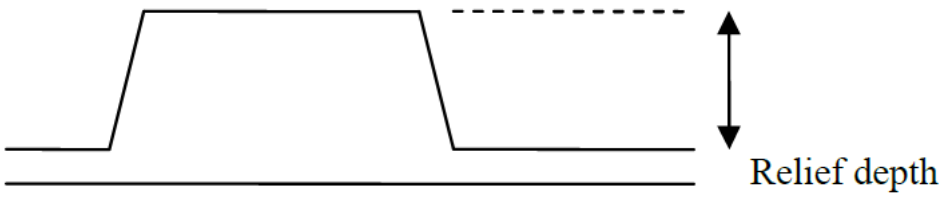
Check the dot-diameter of the 0.5% circular (round) dot.

Measure the top of the dot:



Relief Depth

Measure the relief depth:



Expected dotsizes

The table elements is showing Dotsize for a 0.5% circular dot at 4000 dpi (in micron).

Type	133lpi	150lpi	175lpi	200lpi
DuPont				
DPN		23	20	15
DPR	30	25	21	
DPI	30	25	21	
DFH		27	25	21
DFQ		24	20	15
DFS		25	20	

Type	133lpi	150lpi	175lpi	200lpi
Flint				
ACE		20	17	15
ACT		20	17	15
FAB	27	23	21	18
FAC	20	19	18	13
Asahi				
DSF	30	25	20	15
DEF		10	10	
DSH	25	20	15	
Mc Dermid				
Rave	27	20		
DMAX		40		

Size is in µm = 0.001mm = 0.000039"

One tickmark on the 100x peak microscope is 10 µm.

HD Flexo Plate reference

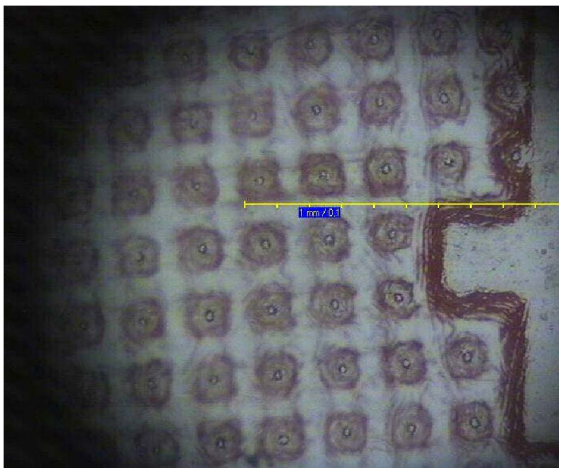
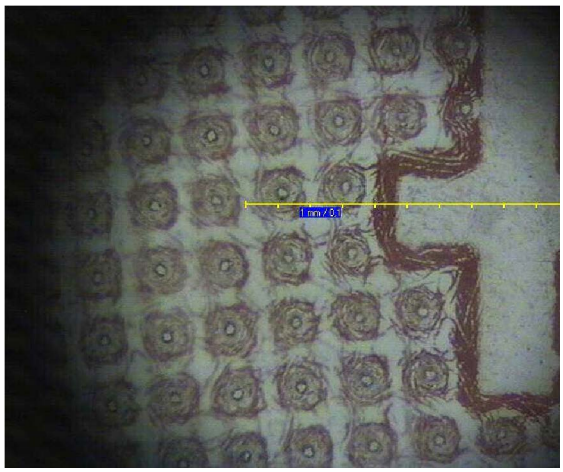
Appendix B HD Flexo Plate reference round top on page 63 is helping to identify problems in platemaking.

8.4. UV Exposure

Intensity Recommendations

UV-Exposure is a critical factor in platemaking. As we need small stable dots this is more demanding for HD Flexo.

The following picture shows the 4% field on a DFH45 with different UV-intensity:

	
16mW/cm^2	20mW/cm^2

- Therefore we recommend to have more than **18mW/cm^2** UV intensity.
- Values below 18mW/cm^2 and above 16mW/cm^2 are usable, but quality will suffer. A bump curve or bigger HD-dots may be used to compensate.
- Values below 16mW/cm^2 will require a bump curve for standard quality.
- The higher the temperature during UV-Exposure the weaker the dots will be.
- The exposure frame should have a cooled bed (not a glass bed).
- FAST plates require a cooled bed and more then 18mW/ cm^2 UV-intensity.

Use a calibrated Kühnast device (IZ001027) to measure the output power.

9. Appendix A HD Flexo 2.0 – "Best Practice" Guidelines

HD Flexo is a technology that improves print quality based on the existing configurations of all platemaking and printing environments. HD Flexo is an open system designed to work with all digital flexo plates available in the market, with all press setups and ink systems. Esko Artwork is continually extending HD Flexo to encompass new and existing digital flexo plates and flexo print applications.

HD Flexo is designed to

- increase the tonal range in the highlight as well as in the shadows
- print smooth transitions to zero
- increase the tonal dynamics and contrast of images - increase consistency and repeatability on press.

To achieve maximum quality, the following guidelines should be followed:

Printing with UV inks

Printing applications:

- Labels, Folding Carton, Flexible Packaging and others

Plate recommendations (other plate types supported as well):

- DuPont DFQ, DPN, DPI, DPR
- Flint ACE, FAB
- Asahi DEF

HD screen selection:

- HD screen selection from "HD Flexo Installer - Labels section" Repro requirements:
- Digital noise should be eliminated from images by using EskoArtwork FlexoTools (clean below 0,78%)
- Technical vignettes to zero should end at 0.38%
- Round Fogra dot shape should be used for substrates sensitive to mottling (e.g. paper label stock)
- Job-linecount from 133lpi (52 L/cm) to 225lpi (80 L/cm) depending on Anilox quality
- HD screens should be used w/o any bump-up Tape recommendations:
- Medium hard tapes Printing requirements:
- Anilox system should match job requirements:
  - Anilox-LPI ≥ 5 x Job-LPI
  - Anilox cell volume < 5 cm^3/m^2 (3 BCM/in^2) in case transitions to zero are required

Printing with water based inks

Printing applications:

- Corrugated Pre-Print and Post-Print, Folding Carton and others Plate recommendations (other plate types supported as well):
- Corrugated Post-Print: DuPont DPN, DuPont DS2, Flint ART
- Corrugated Pre-Print: DuPont DPR, DuPont DS2, Flint ART, Flint ACT

- Folding Carton: DuPont DPR, DuPont DPN, DuPont DFQ, Flint ACT HD screen selection:
- HD screen selection from "HD Flexo Installer - Corrugated section" or "HD Flexo Installer - Folding Carton" section Repro requirements:
- Digital noise should be eliminated from images by using EskoArtwork FlexoTools (clean below 0.78%)
- Technical vignettes to zero should end at 0.38%
- Round Fogra dot shape is recommended
- Job-linecounts (depending on Anilox and substrate quality):
    - Corrugated pre-print: 133lpi up to 175lpi o Corrugated post-print: 100lpi up to 150lpi
        - Folding Carton: 133lpi up to 175lpi
- HD screens should be used w/o any bump-up Tape and mounting recommendations:
- Soe to medium hard tapes
- 2.84 mm (112mil) plate thickness with compressible undercut for Post-Print corrugated

Printing requirements:

- Anilox system should match job requirements:
    - Anilox-LPI ≥ 5 x Job-LPI
    - Anilox cell volume < 5 cm^3/m^2 (3 BCM/in^2) in case transitions to zero are required

Printing with solvent inks

Printing applications:

- Flexible packaging and others

Plate recommendations (other plate types supported as well):

- For best overall quality use a hard plate (e.g. DuPont DPR/DFQ, Flint ACE, Flint FAB, MacDermid RAVE, Asahi DSH) with which you can expect excellent highlights and smooth transitions to zero on a suitable ink system (see below)
- Where highest ink density is required, and for white or spot color printing, use a softer plate (e.g. DuPont DS2/DFS, Flint ACT, MacDermid DMAX, Asahi DSF). Transitions to zero are more difficult to achieve using these plate types.

HD screen selection:

- For hard plates use screens from either the Flexibles Low Volume (LV) or Flexibles Medium Volume (MV) section of the screen installer as indicated in the following table:

Anilox Ruling Anilox Cell Volume	275–355 L/cm 700–900 LPI	355 L/cm–600 L/cm 900 LPI–1500 LPI
4.6 cm^3/m^2–7 cm^3/m^2 3 BCM/in^2–4.5 BCM/in^2	MV mandatory	MV recommended LV possible
1.5 cm^3/m^2–4.6 cm^3/m^2 1 BCM–3 BCM	MV recommended LV possible	MV possible LV recommended

- For softer plates, always use screens from the Flexibles Medium Volume (MV) section of the screens installer Repro requirements:
    - Digital noise should be eliminated from images by using EskoArtwork FlexoTools (clean below 0.78%)

- Technical vignettes to zero should end at 0.38%
- Job-linecounts 120lpi to 225lpi (depending on Anilox and ink quality)
- HD screens should be used w/o any bump-up
- When using softer plates and/or MV screening, transitions to zero will be hard to achieve. In these cases use a “minimum-dot” repro (running dot) instead.

Tape recommendations:

- With hard plates, use a medium-firm mounting tape such as Lohmann 5.3 or equivalent
- With softer plates, use a medium-soe mounting tape such as Lohmann 5.2 or equivalent
- High performance mounting tapes (eg the Lohmann HP series) are preferred in order to maintain dot stability over longer print runs Printing requirements:
- Anilox system should match job requirements (Anilox-LPI ≥ 6 x Job-LPI)
- Standard inks with standard viscosity (22s or above)
- Ink drying must be well controlled when printing transitions to zero
- In case of printing problems, refer to the HD Flexo Applications Guide for additional advice on troubleshooting

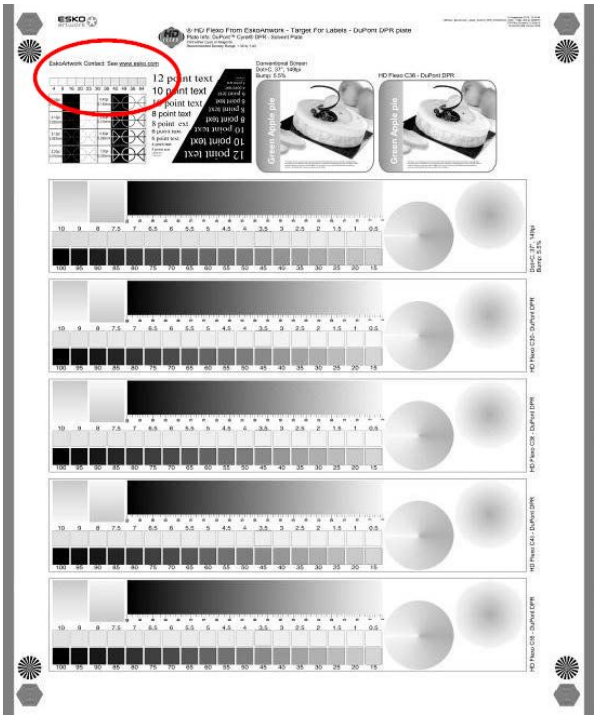
10. Appendix B HD Flexo Plate reference round top

Intension

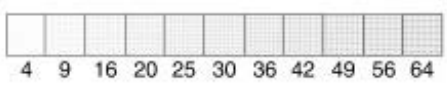
Judge a plate for decent platemaking. Especially main - UV - exposure.

How it works

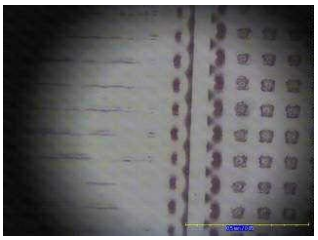
Each HD Flexo target contains a dot-fail-stripe which is the same for all plates and linecounts.



The number below the fields indicates the number of pixel used for a square dot. So the field 16 is filled with dots of 4*4 pixel, the 20 of 4*5 pixel...

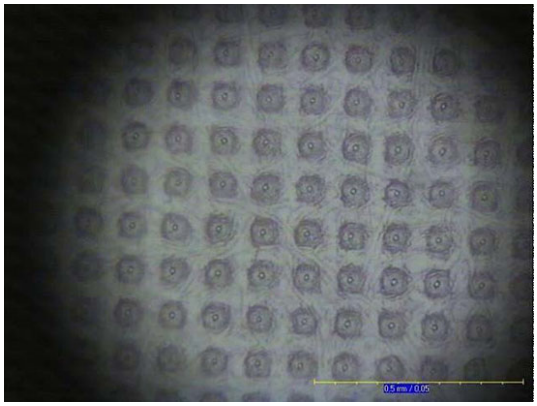
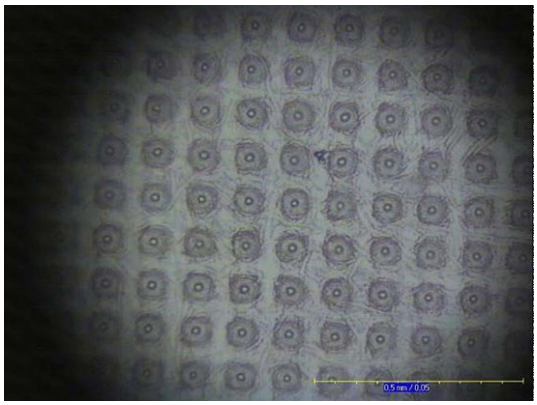


In new templates the dot-fail-stripe consists of three rows. We refer to the top row in this document which is equal to older one-row layout. The following table show's pictures of these fields. The first picture is taken from the field which has recognizable dots inside (stable or not).

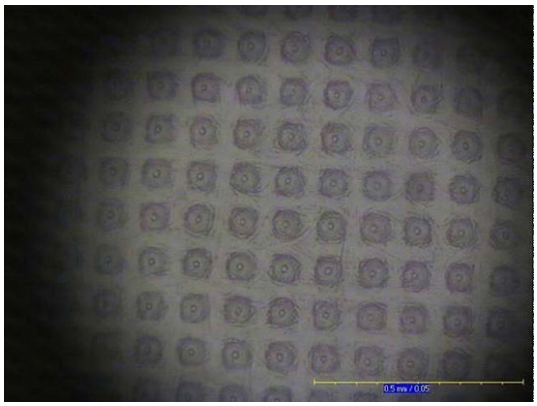
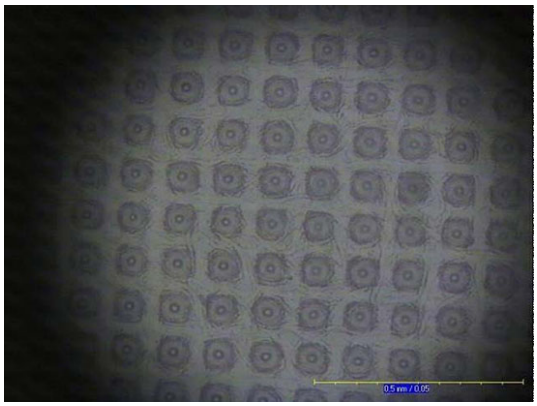

Left side 9 pixel right side 16 pixel

The field on the left side is empty like in the picture above. The second picture is taken from the field to the right.

DuPont DFH45

	
16	20

DuPont DFH67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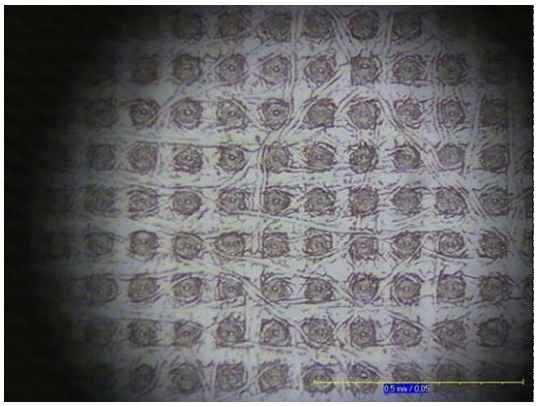
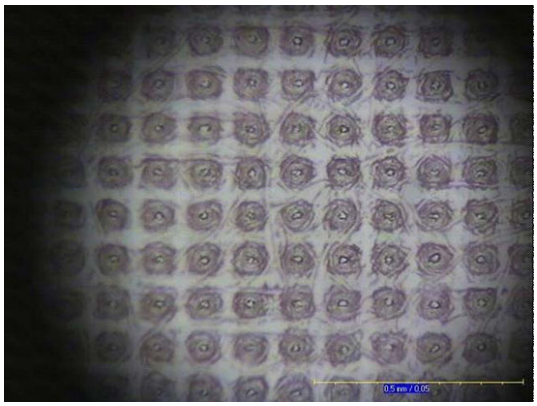
DuPont DFQ45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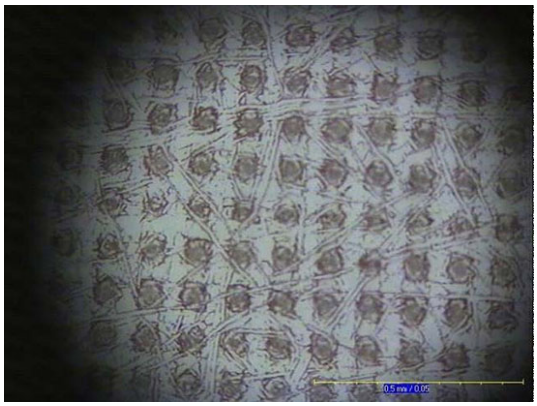
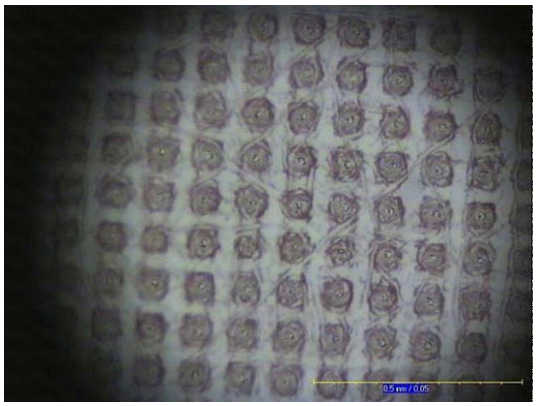
DuPont DFQ67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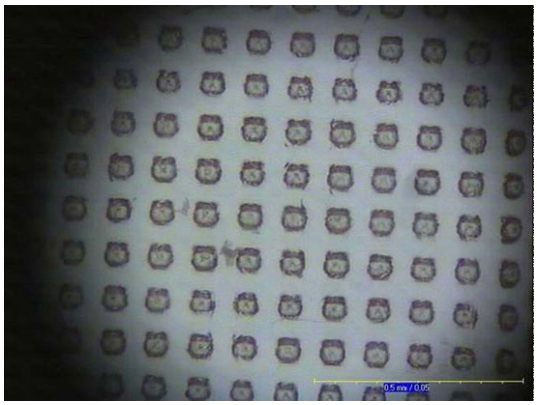
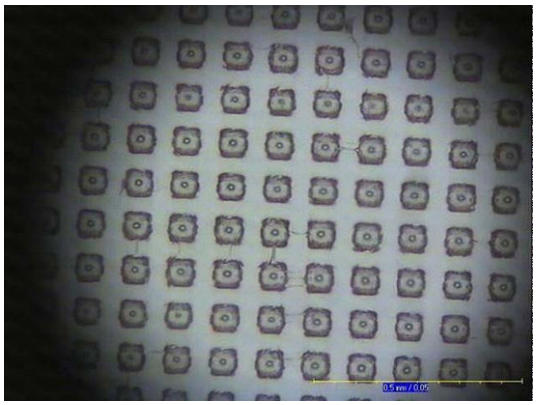
DuPont DPI45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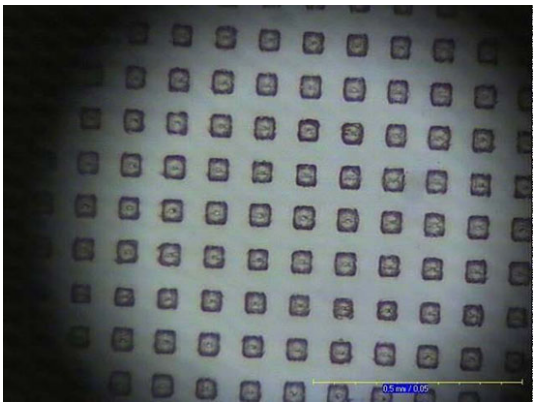	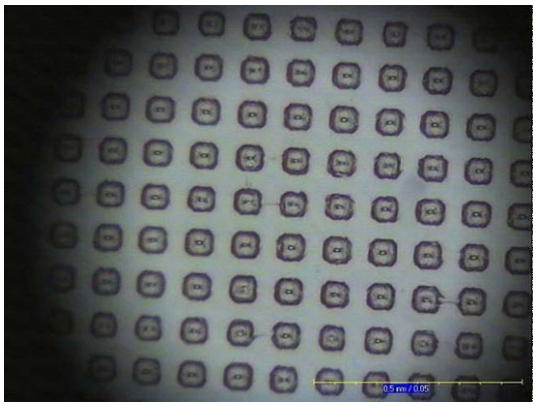
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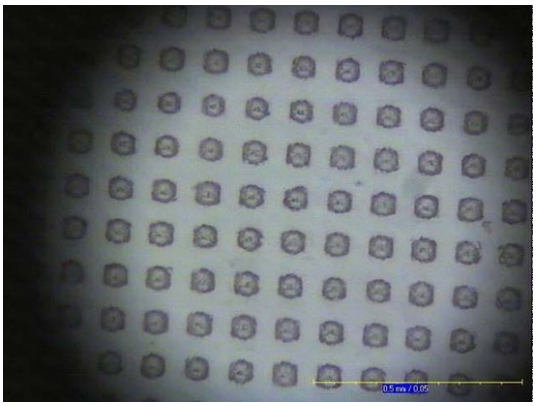	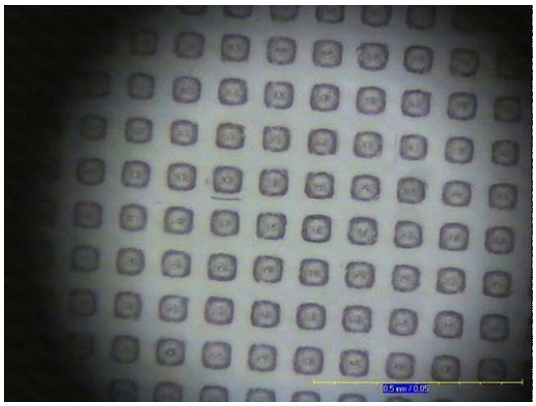
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	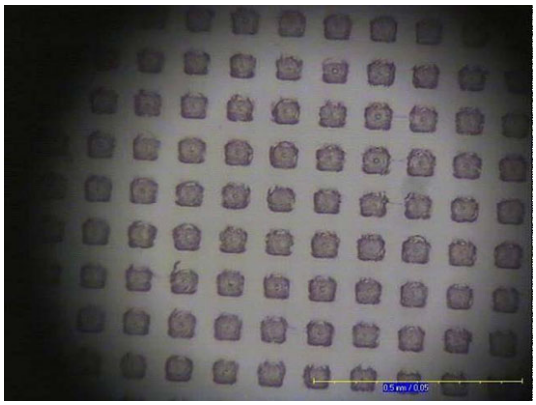
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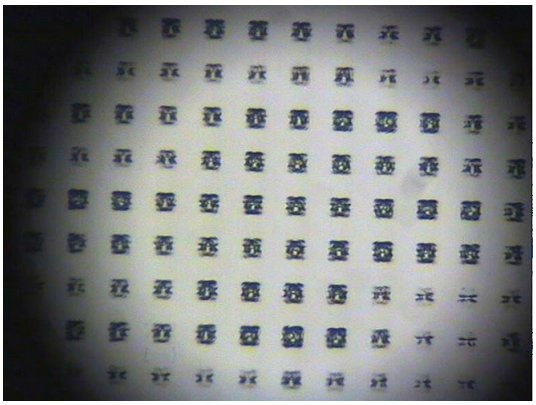
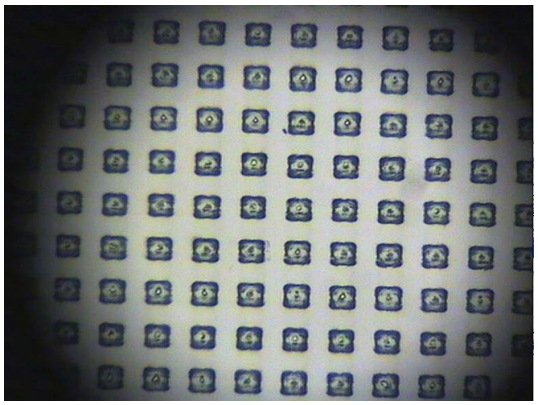
Flint ACE45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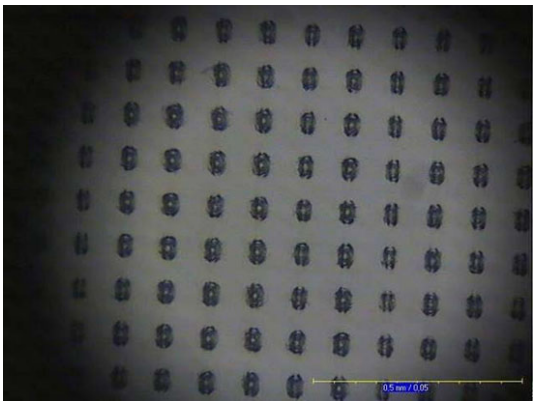	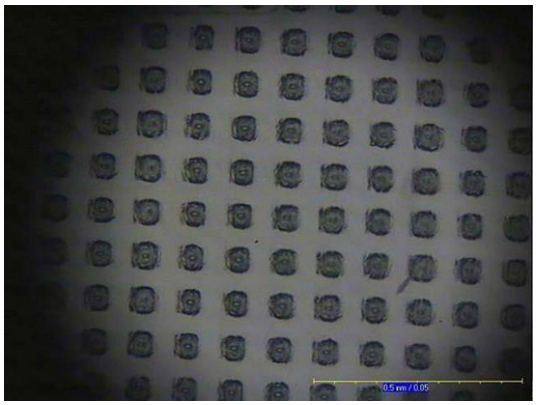
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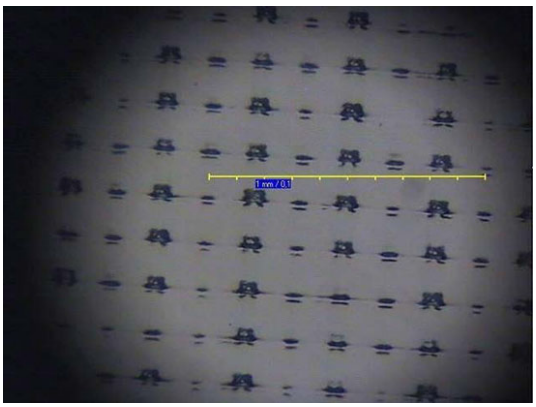	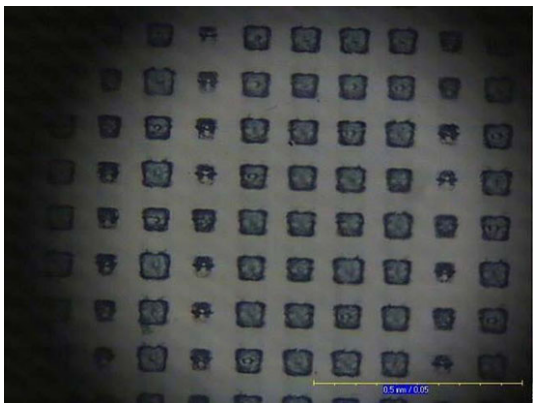
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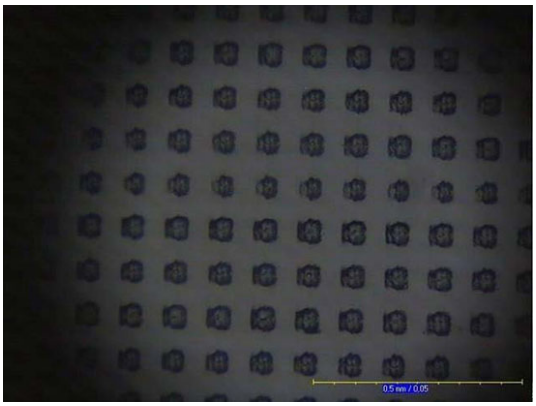	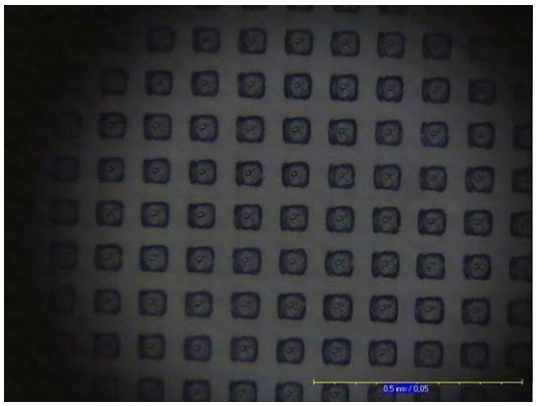
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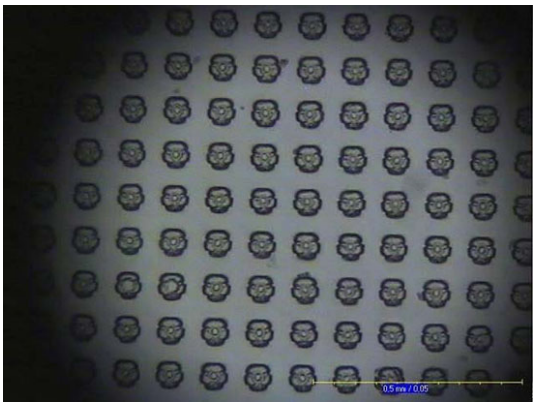	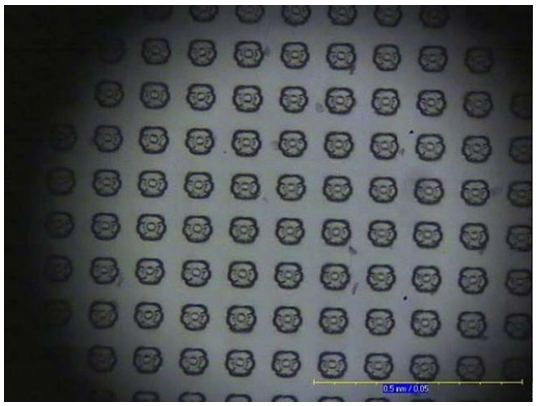
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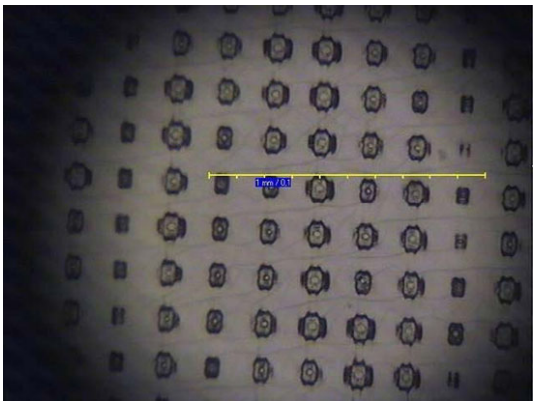	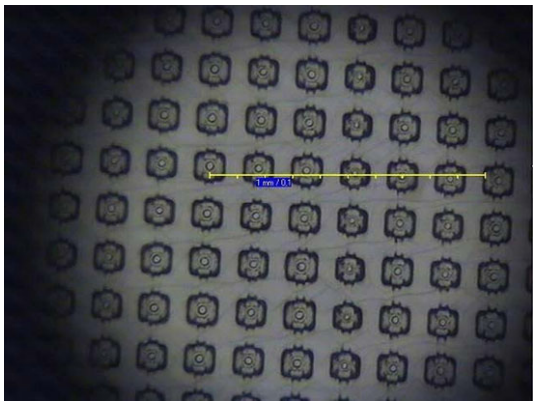
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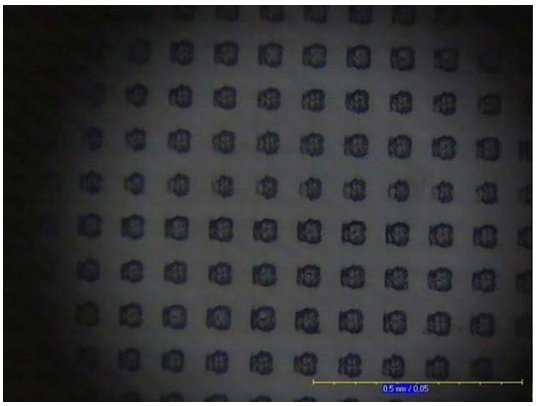	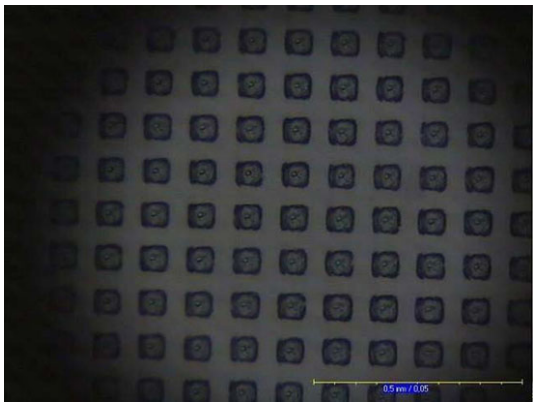
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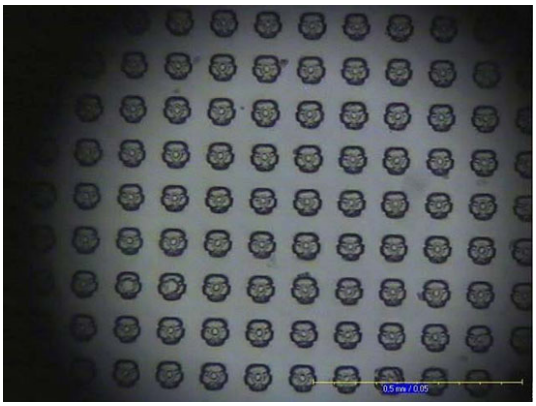	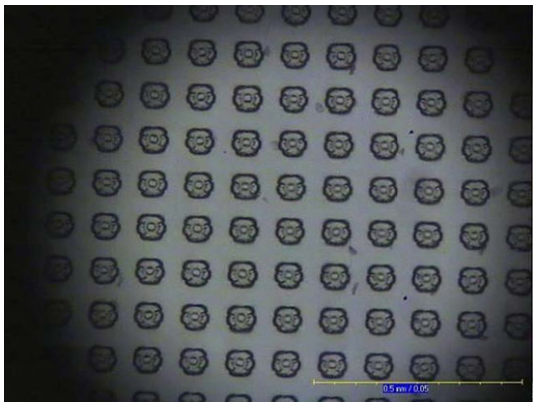
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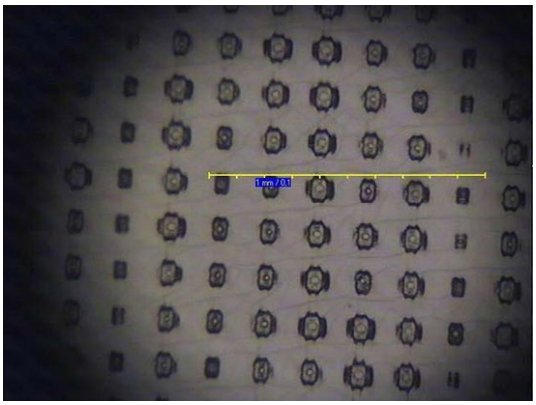	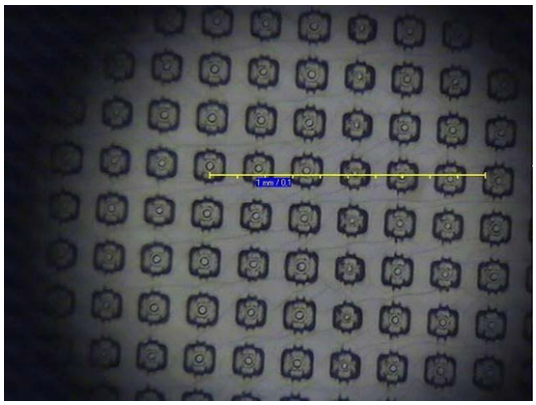
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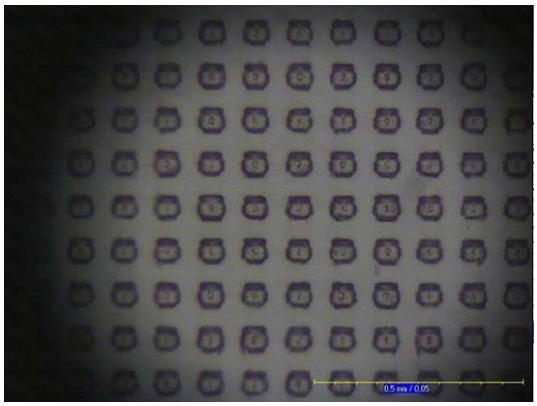
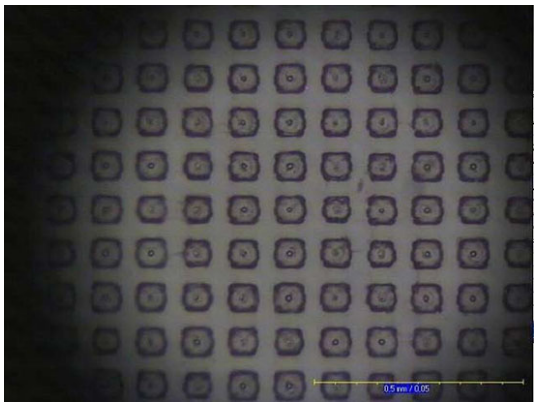
MacDermid MAX67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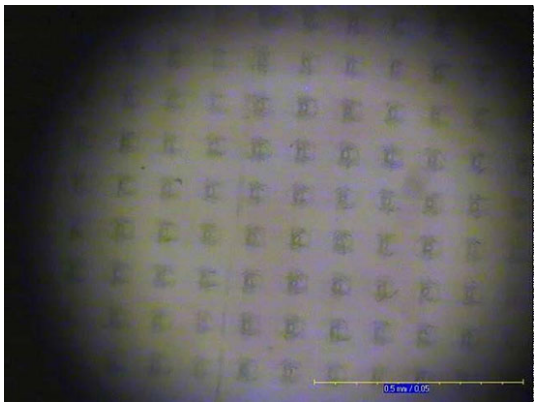
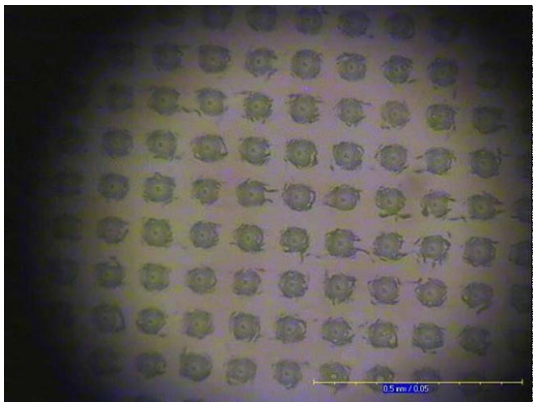
Asahi DEF45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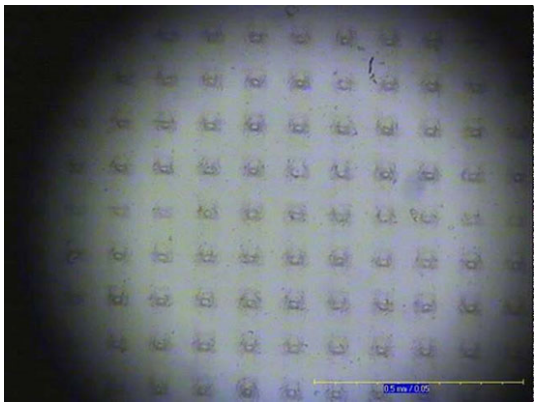
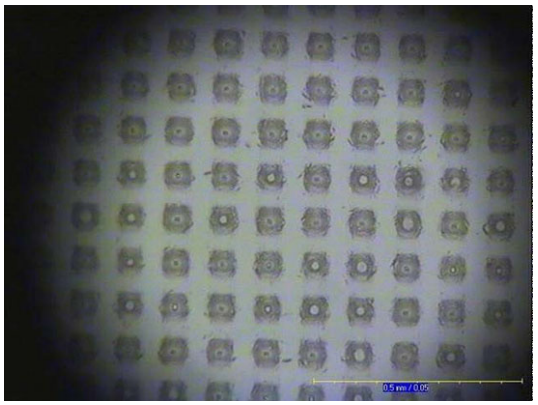
Asahi DEF67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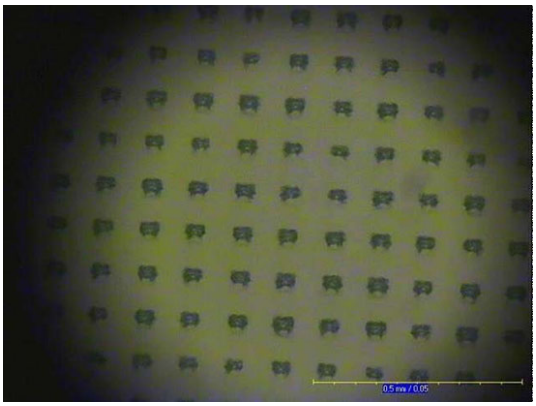
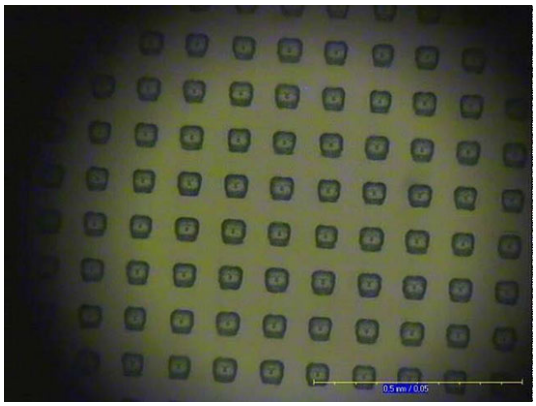
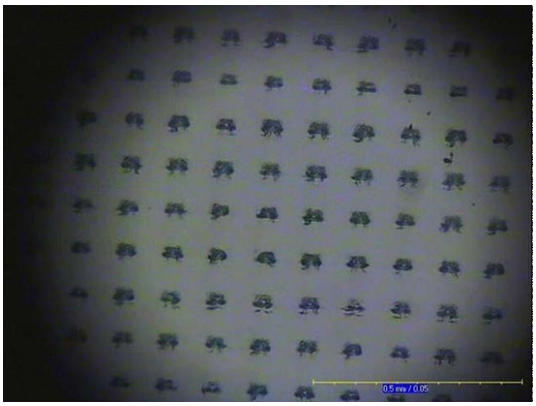
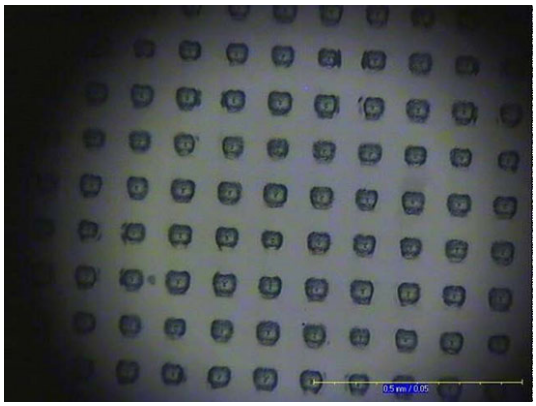
Asahi DSF45

	
20	25

Asahi DSF67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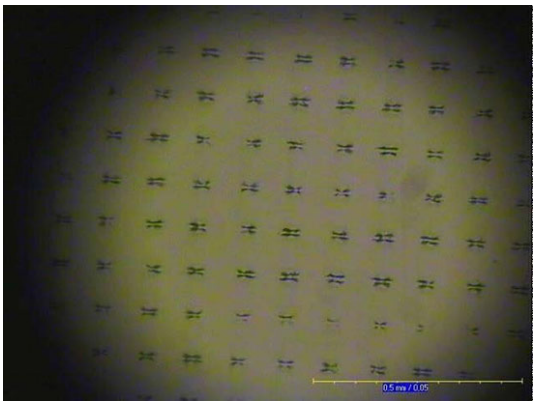
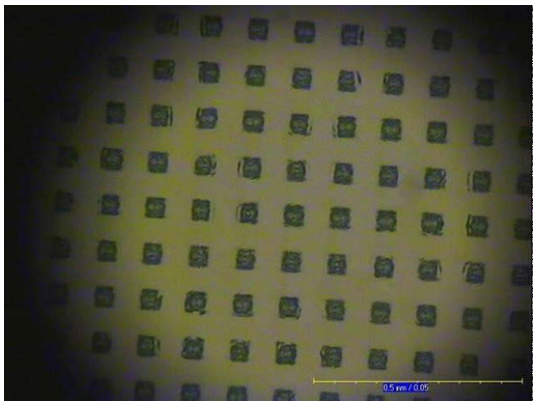
Asahi DSH45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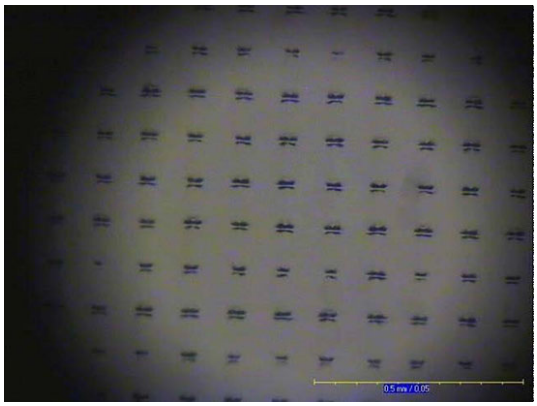
Asahi DSH67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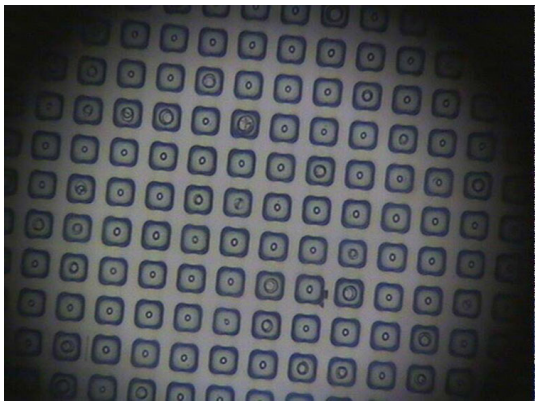
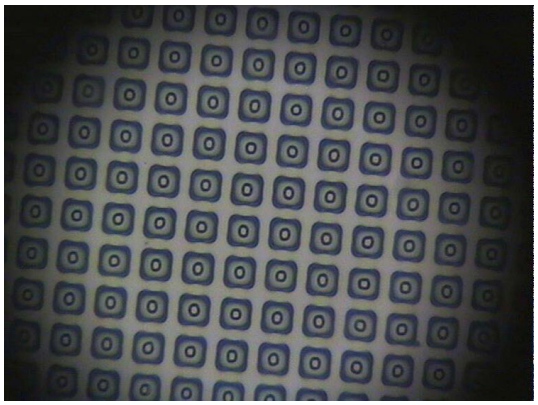
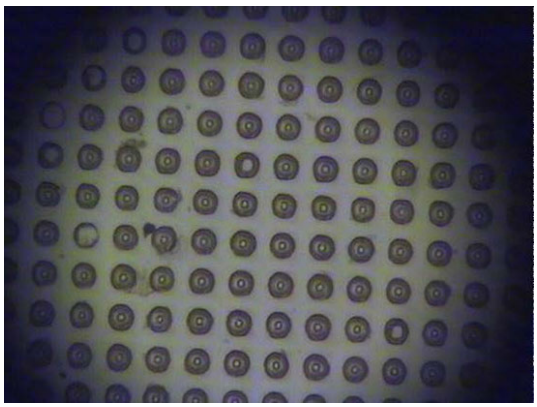
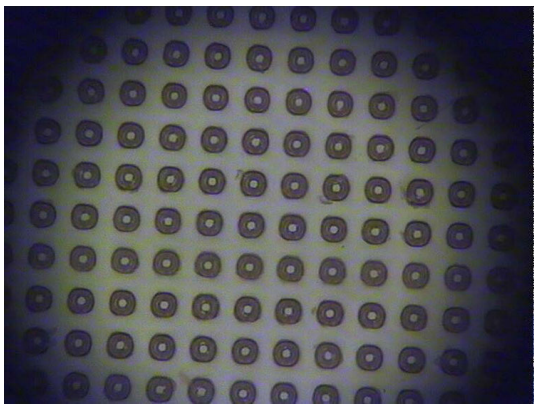
Dantex DRF80

	
4	9

Jet LSL114

	
4	9