



Print Surface Engineering: Retrospective on Microcell Patterns in Flexographic Printing



March 17-19, 2026
VIRTUAL EVENT



MAREK SKRZYNSKI
VP of Technology & Innovation

FLEXO TIMELINE : From Rubber to Digitally Imaged Photopolymer

1890

RUBBER PRINT

First Flexo press patented by Bibby, Baron, & Sons in Liverpool, UK



OUR LEGACY

1952

FLEXOGRAPHY (official name)

Rebranding with safer, food grade inks approved by FDA



1920

ANILINE DYES

Enhanced color vibrancy but raised ink toxicity



1974

PHOTOPOLYMER PLATE

Invented by DUPONT, replacing traditional rubber



1980s

ANILOX (laser engraved)

Dramatic improvement in ink transfer and control



1995

PLATE CDI IMAGER

First BARCO Cyrel Digital computer to plate Imager



2000s

LAMS DIGITAL PLATES

HD screening, Flat-tipped dots, microcell



THE FUTURE

For nearly 100 years, Flexo plate was the limiting factor

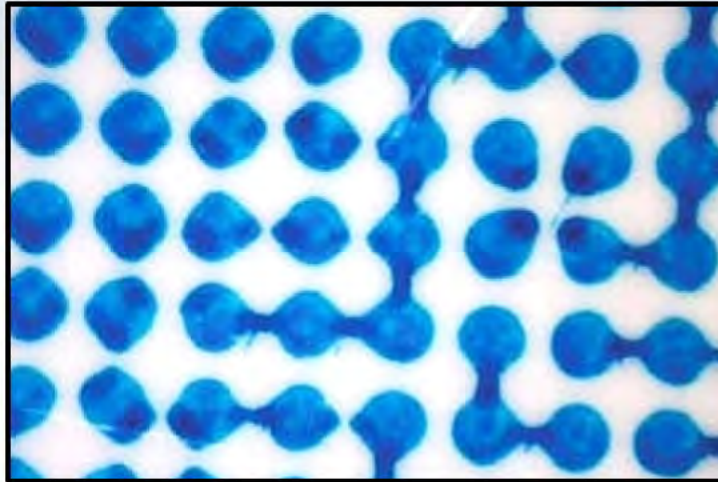
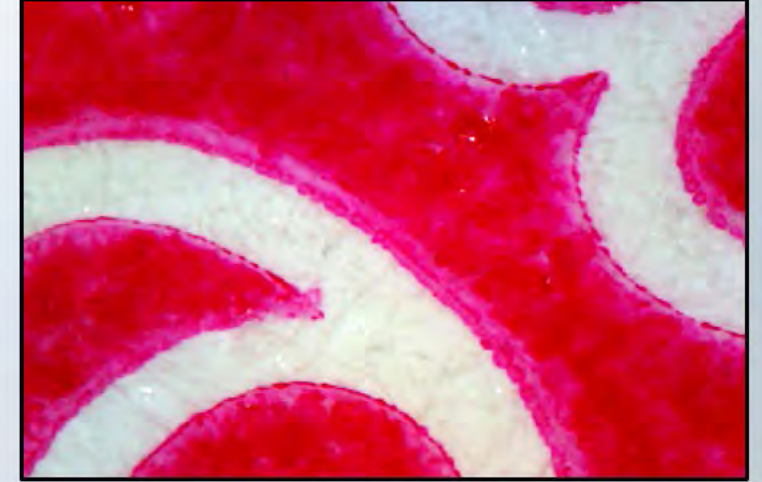
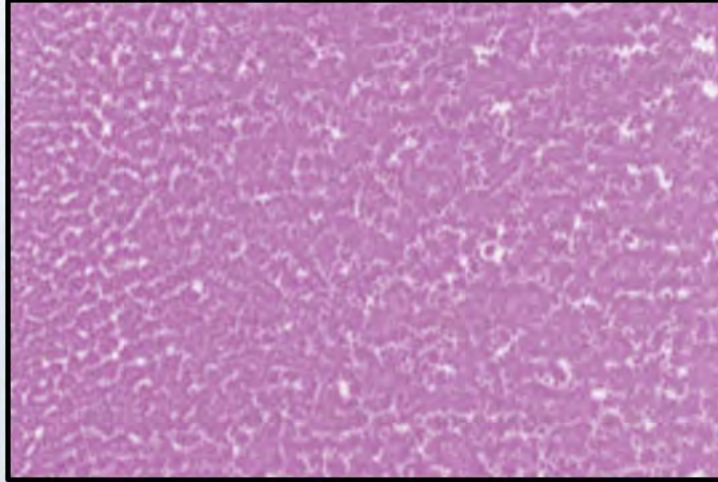
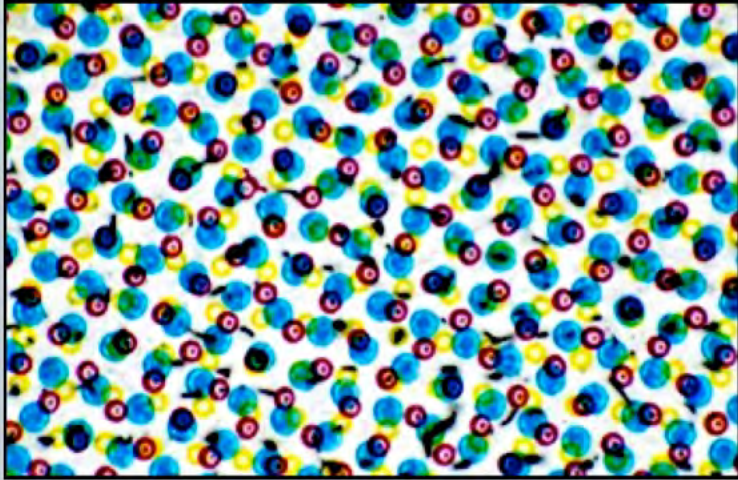
FLEXO vs. GRAVURE: Old Rivalry



fast set-up & turnaround times
cost-effective (short /medium runs)
versatile (substrates & inks)
eco-friendly options

high-quality with intricate details
vivid colors
smooth gradient effects
durable during long runs

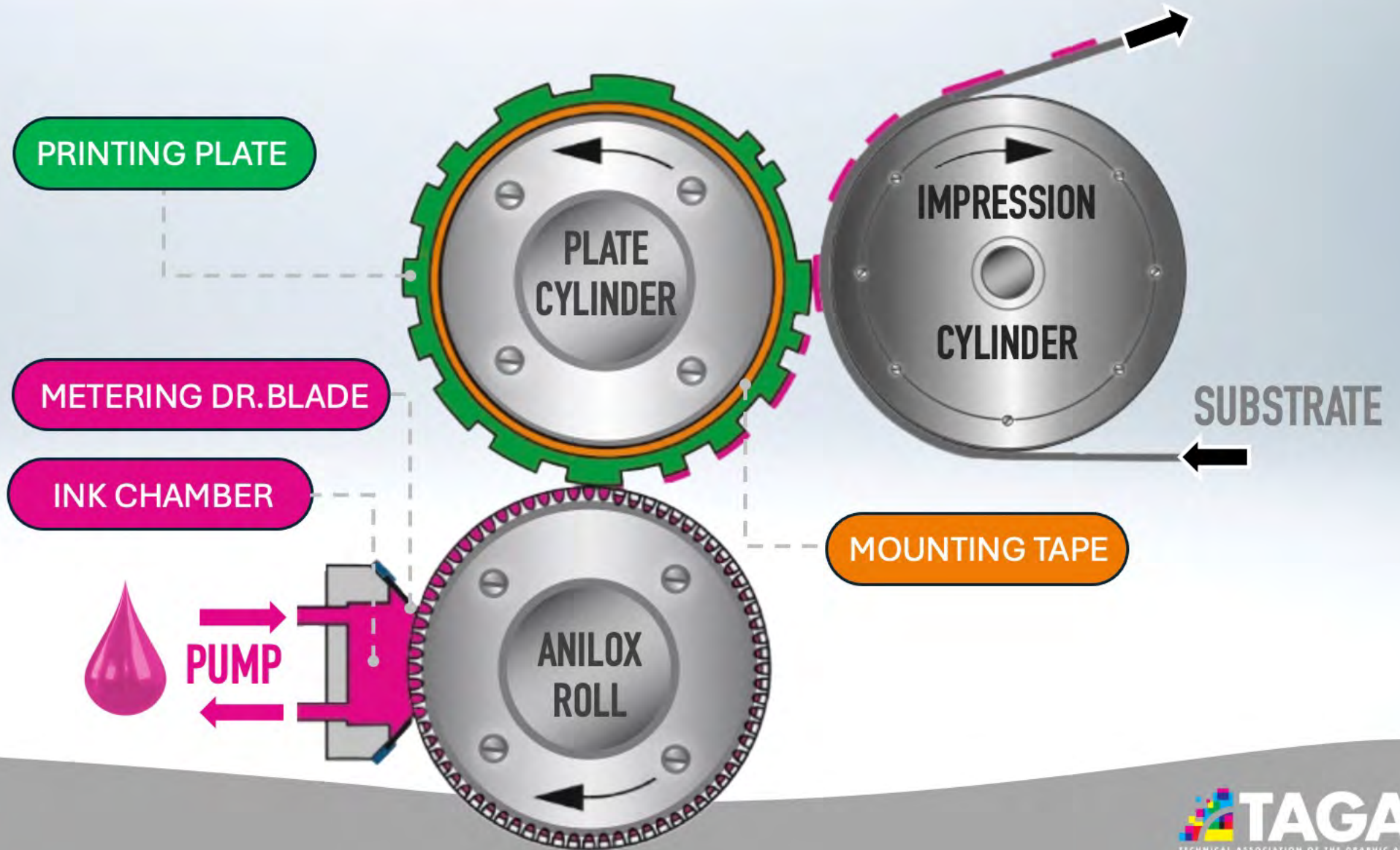
FLEXO LEGACY : Ink transfer and laydown challenges



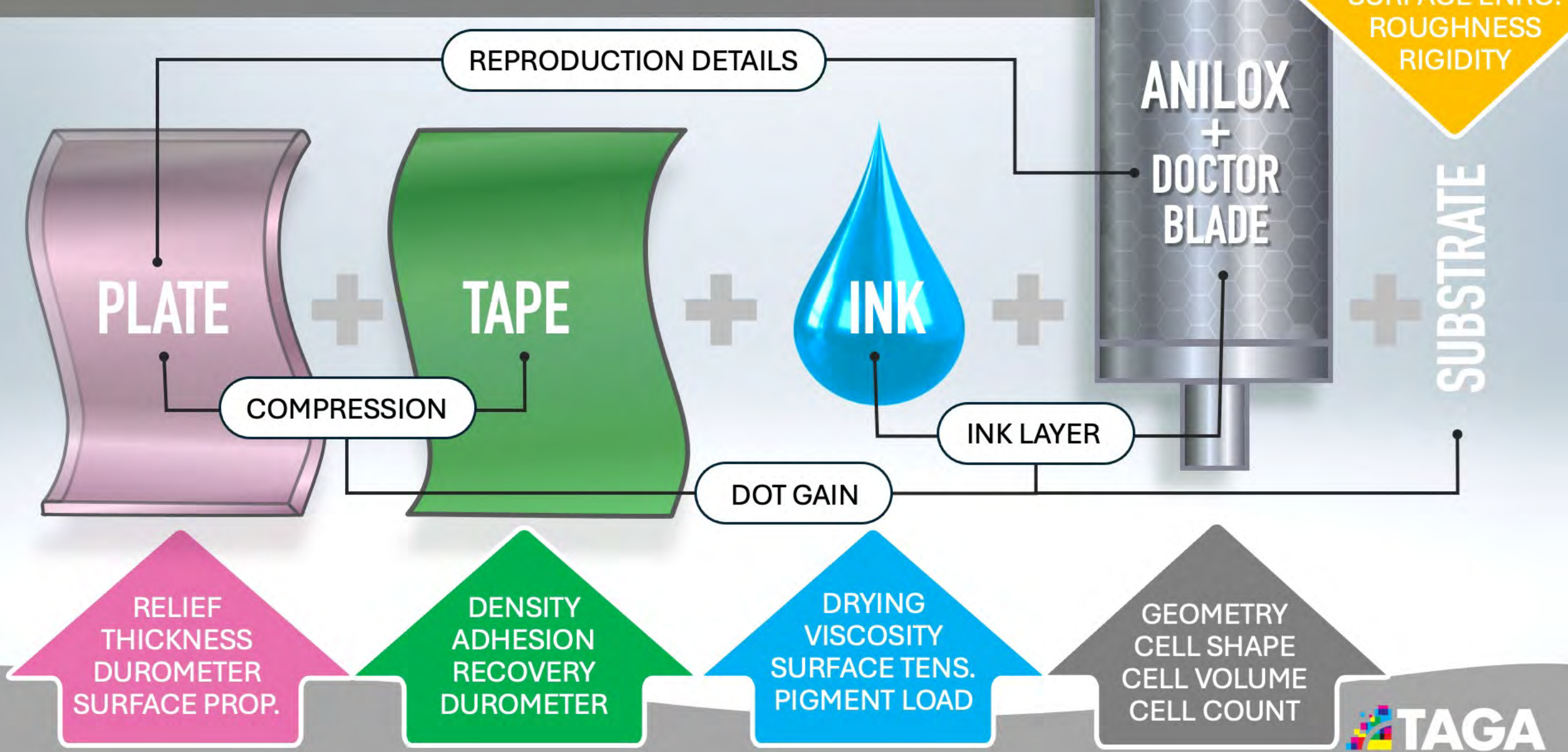
**pinholing / voids in solids,
vignette with hard edges,
dot-bridging / dirty print,
over-impression / dot gain,
halo / edge void,
...etc.**

FLEXOGRAPHY: The basic components of ink transfer system

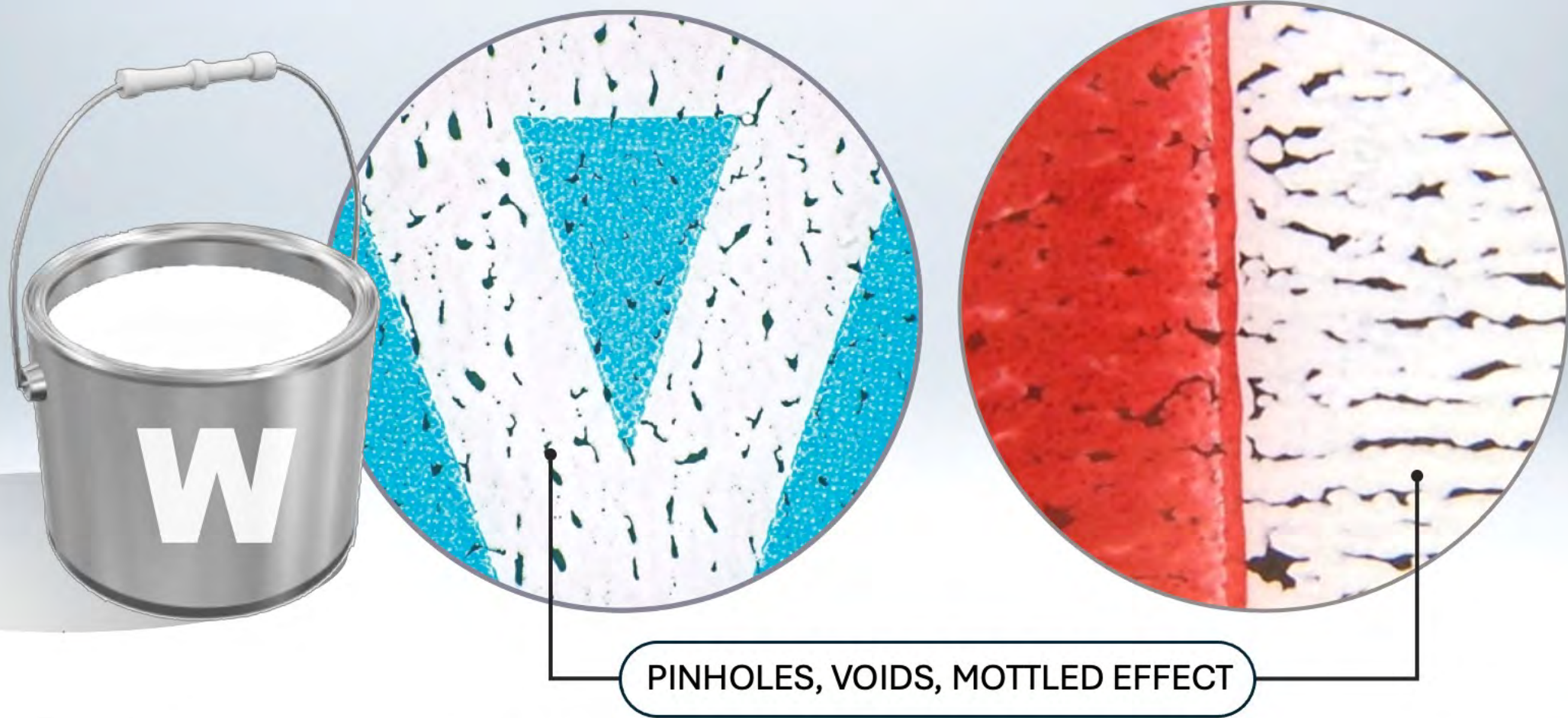
A high-speed, rotary-style relief printing process using flexible photopolymer plates to transfer ink onto diverse, often non-porous materials



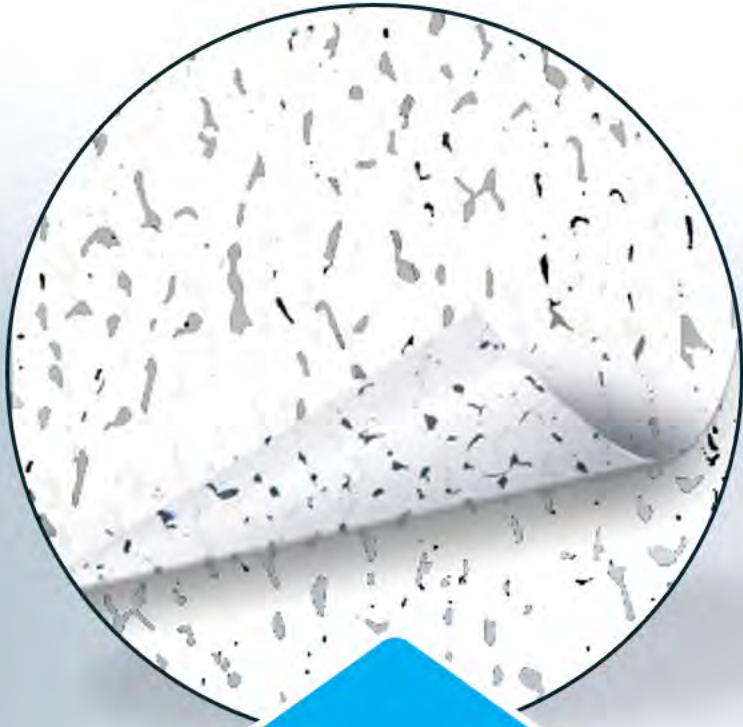
FLEXO INK TRANSFER: Interaction Complexity



COMPROMISED WHITE FOUNDATION AFFECTS OTHER COLORS



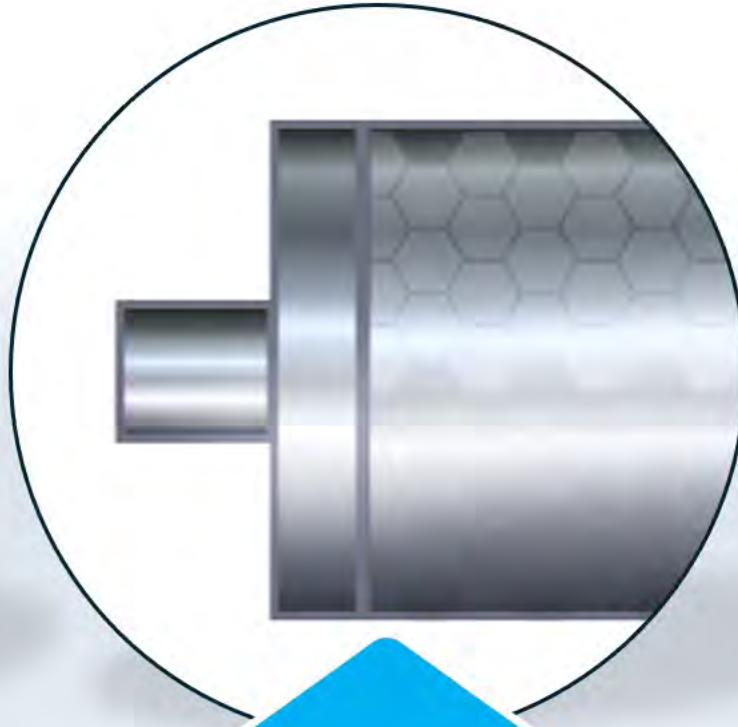
WORKAROUND: Attempting to fix the problem still comes up short...



INCREASED

2X

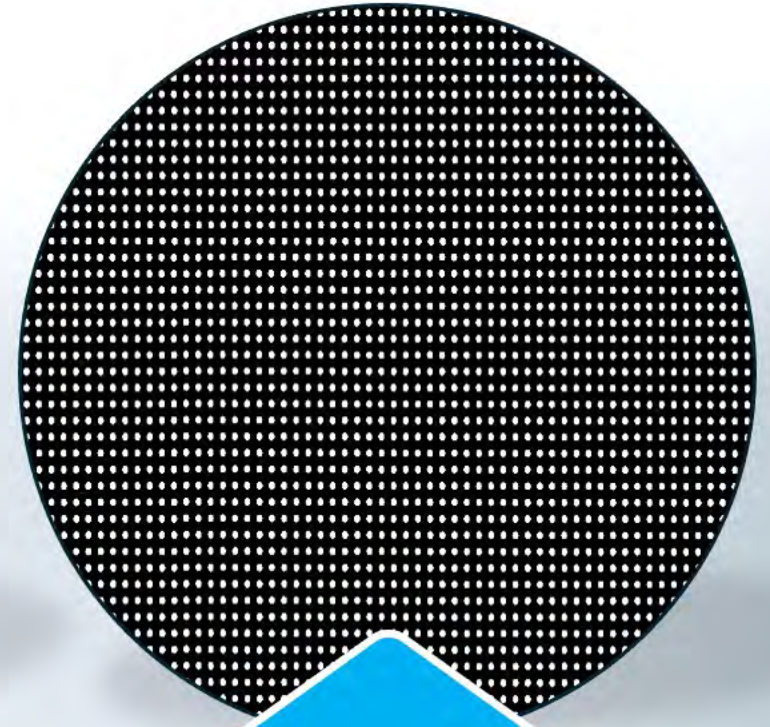
LAYER OF WHITE INK



INCREASED

VOLUME

OF THE ANILOX ROLL

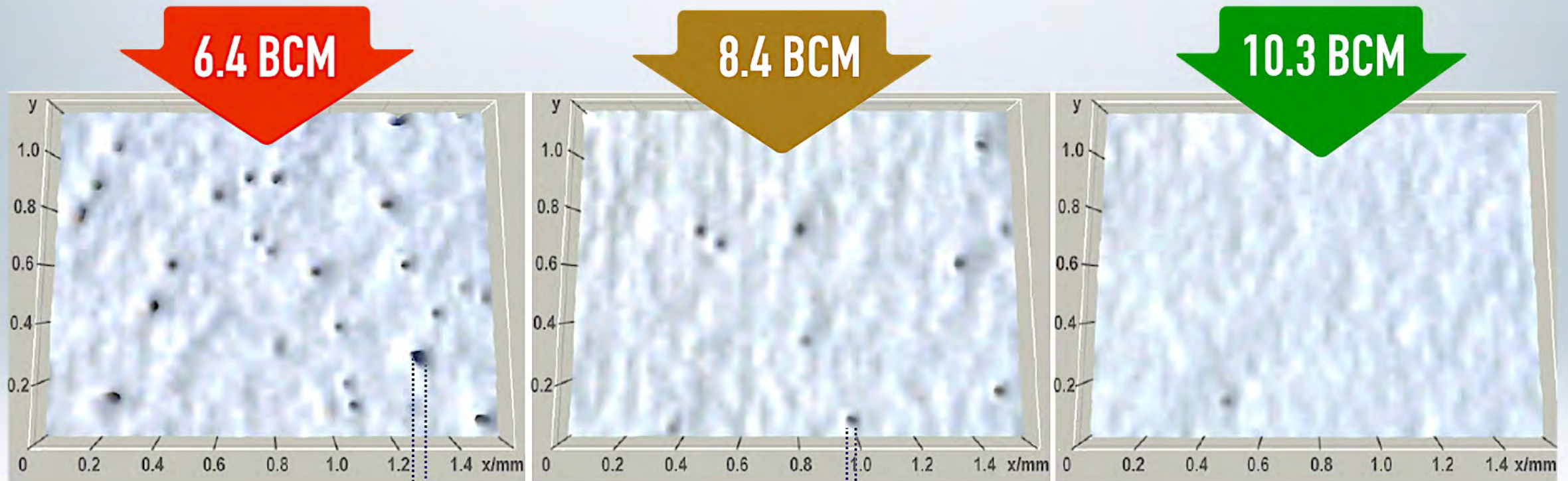


APPLICATION OF

SCREEN

98-99% @ HIGH LPI

THE ANILOX VOLUME TO THE RESCUE: The “old school” approach



900 μm^2 (or 30 μm dot size)

400 μm^2 (or 20 μm dot size)

MORE INK = DECREASED SPEED



Test performed
with .067 plate,
62 shore A

TITANIUM DIOXIDE: Visual improvement vs. print economy



WHITE



When printed on clear film, it's approx. **50%** of the total ink cost, but close to **65%** of the total ink used

WHITE ink generally has a higher concentration of pigment by **20-40%** as compared to other color inks



TITANIUM DIOXIDE: Visual Quality vs. Print Economy

Per metric ton



The cost of TiO_2 continues to soar. Market size is expected to double from **~USD 22.4 billion in 2023** to **~USD 40.9 billion by 2033** with predicted growth at a **CAGR of 6.2%**

CHINA PRODUCES

45%

OF GLOBAL TiO_2 SUPPLY



THE EVOLUTION OF LASER ENGRAVED CERAMIC ANILOXES

ANILOX CELLS SHAPES



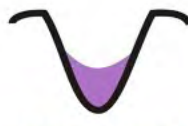
PYRAMID



DULL PYRAMID



SHARP CELL

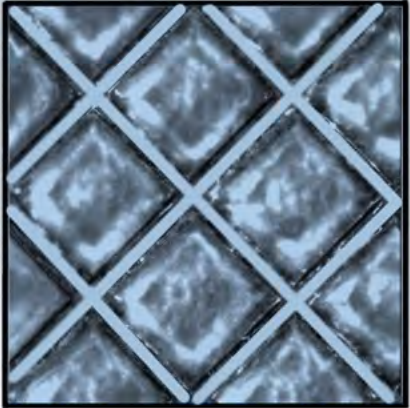


NORMAL CELL



U-SHAPED CELL

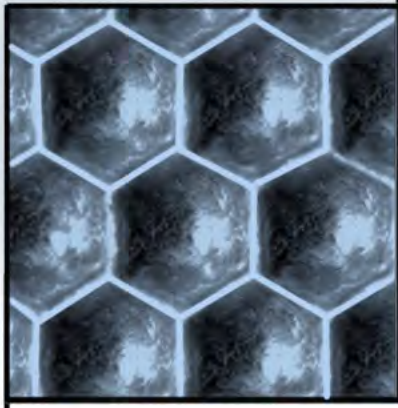
1980s



DIAMOND

Original - 4 Wall Engraving
45°

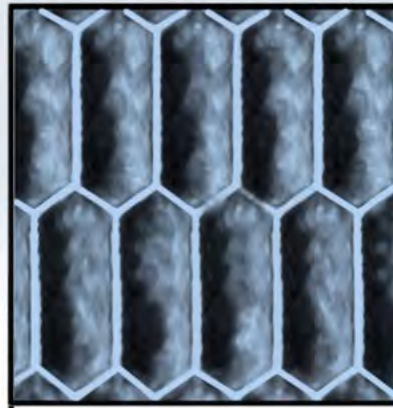
1990



HEXAGONAL

Traditional - Closed Cell
60° - 30°

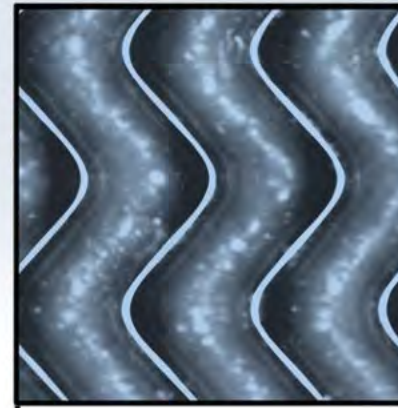
2000



ELONGATED

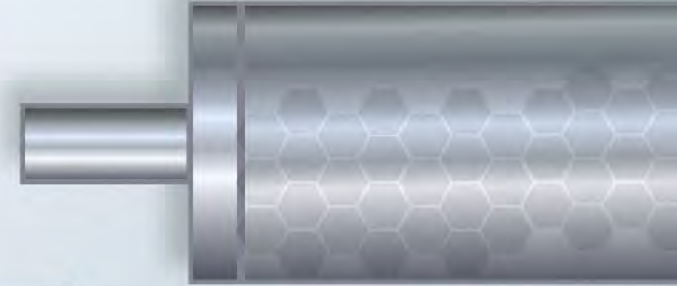
Hex-like w / 2 longer sides
60°

2008



CHANNEL

Open "S"- like geometry

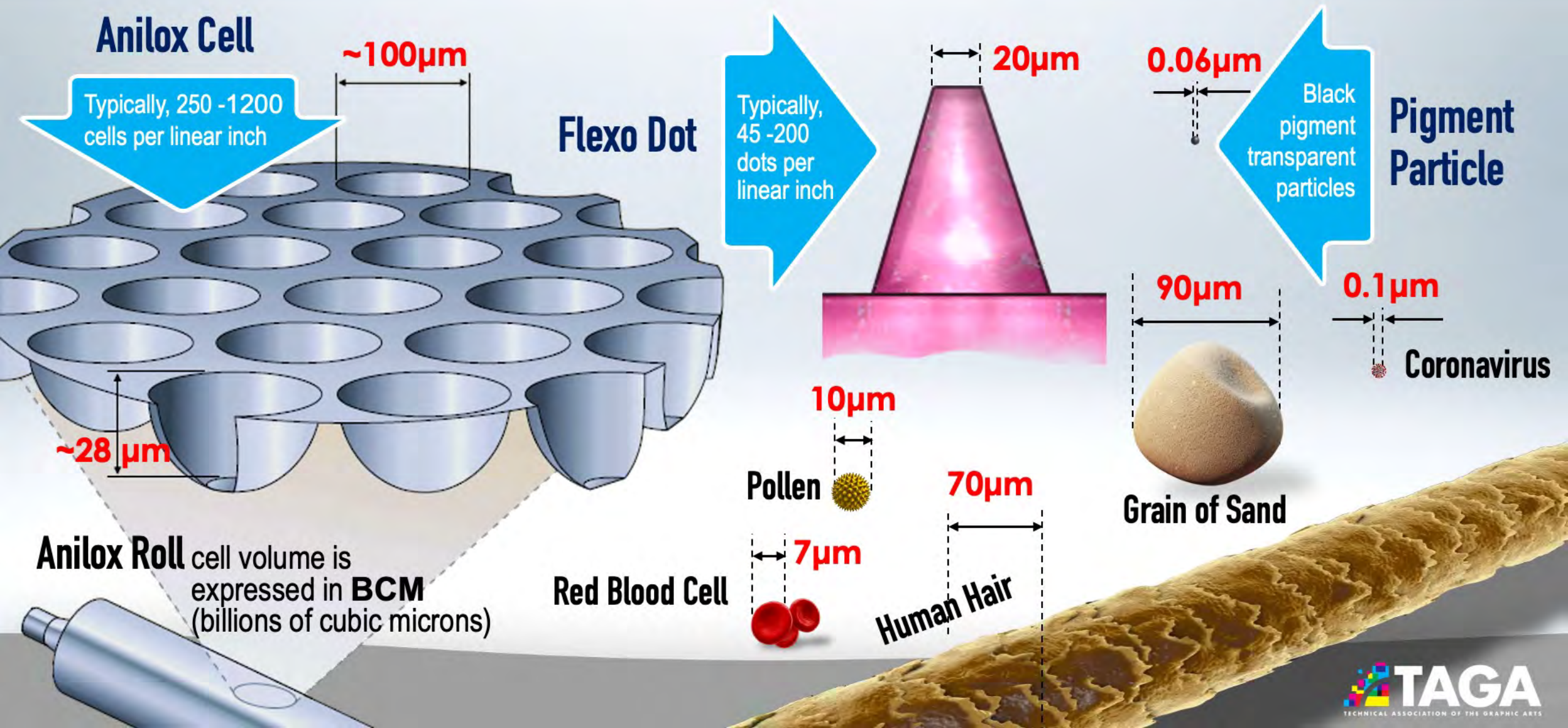


Anilox evolved
from the early
300 LPI
to the latest
1500 LPI

SOURCE:



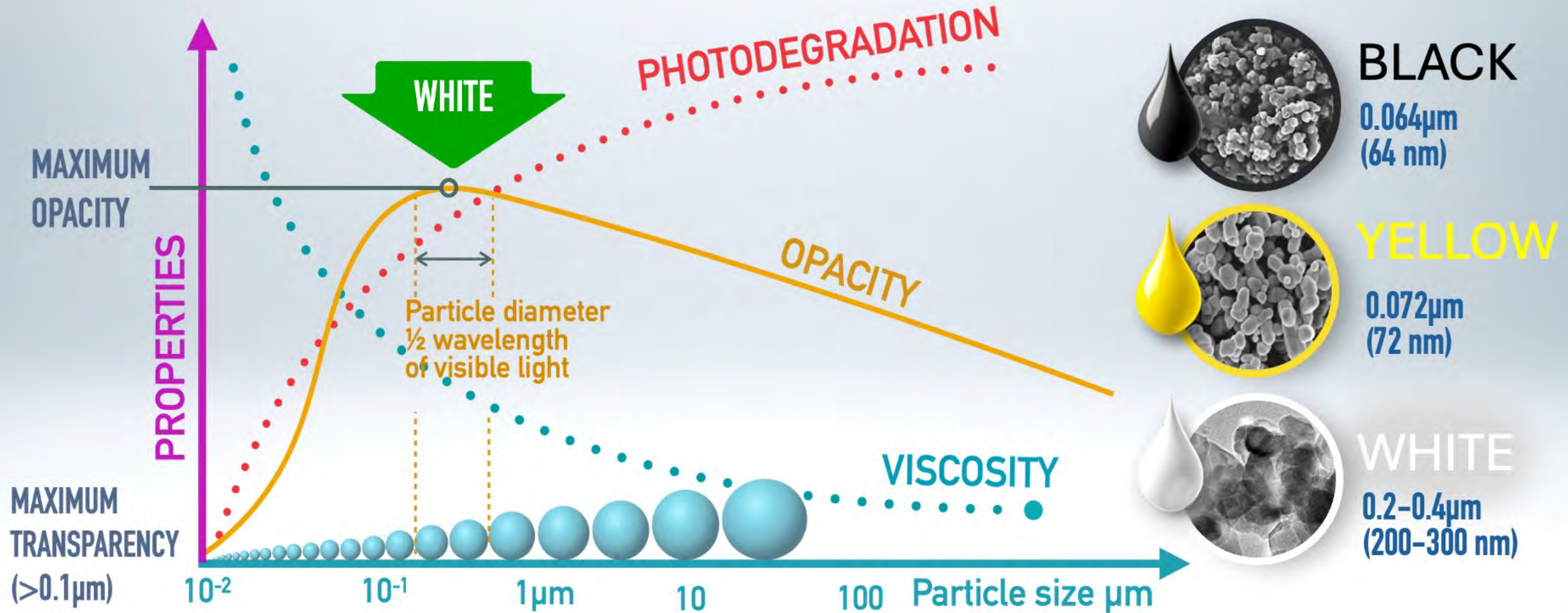
THE SCALE OF A PROBLEM : Understanding the Micro Challenges



THE SCALE OF A PROBLEM : Understanding the Macro Challenges



THE EFFECT OF PARTICLE SIZES ON INK PROPERTIES

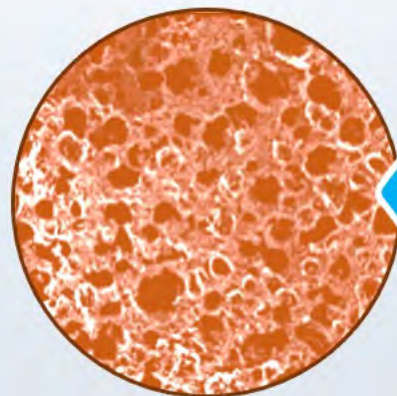


SURFACE PRINT PROPERTIES: Blast from the past...

Excellent details, small text, thin lines, smooth tonal transitions. Less forgiving with large solid areas



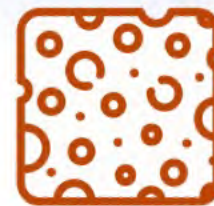
Smooth



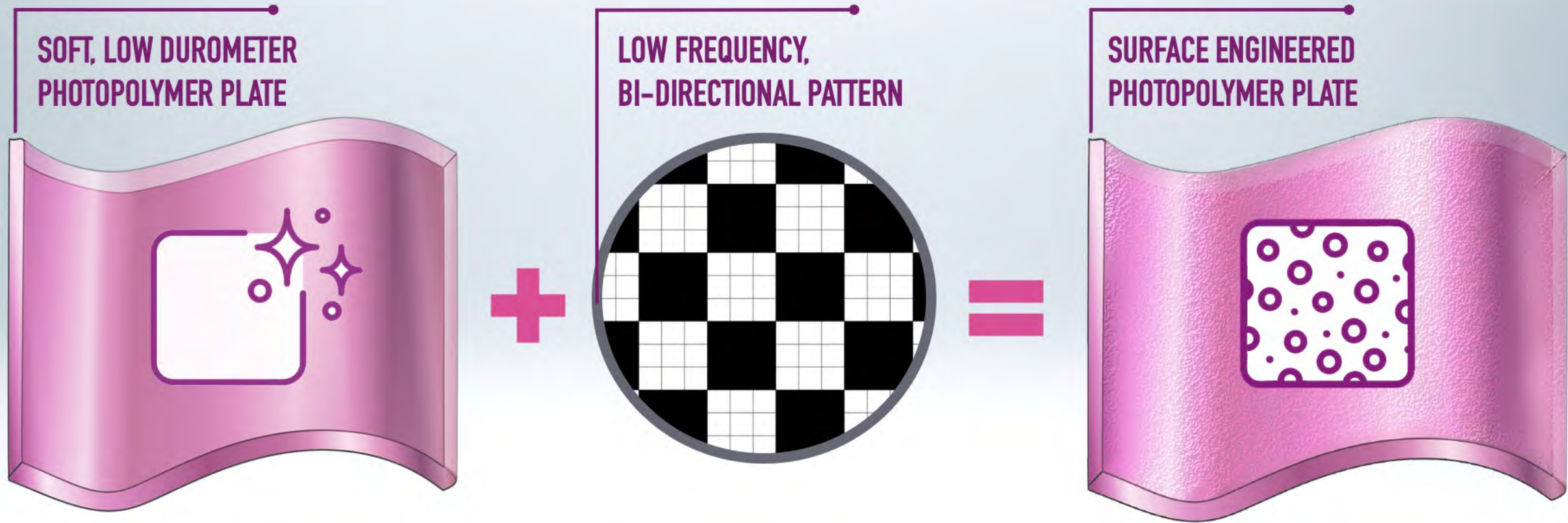
Pores



Excellent for large solid areas and heavy ink coverage. Poor details reproduction, struggle with gradients & thin lines



ALTERING SURFACE PROPERTIES: Lesson learned



EARLY RESEARCH: Plate + Tape + Anilox + Surface Roughness

TAPE: SOFT, MEDIUM, HARD

SOFT PLATE		MEDIUM PLATE		HARD PLATE	
A	 	A	 	A	 
B	  	B	  	B	  
C	   	C	   	C	   
D	  	D	  	D	  
E	 	E	 	E	 
S-0-m	S-2-m	M-0-m	M-2-m	H-0-m	H-2-m

SURFACE PATTERN:

- (A) high frequency
- (B) high tone screen
- (C) no adjustment
- (D) directional pattern
- (E) low frequency

SOURCE:



MacDermid
GRAPHICS SOLUTIONS



cs w inc



WHITE INK LAYDOWN: Flexo obsession with opacity

SINGLE WHITE



SINGLE WHITE

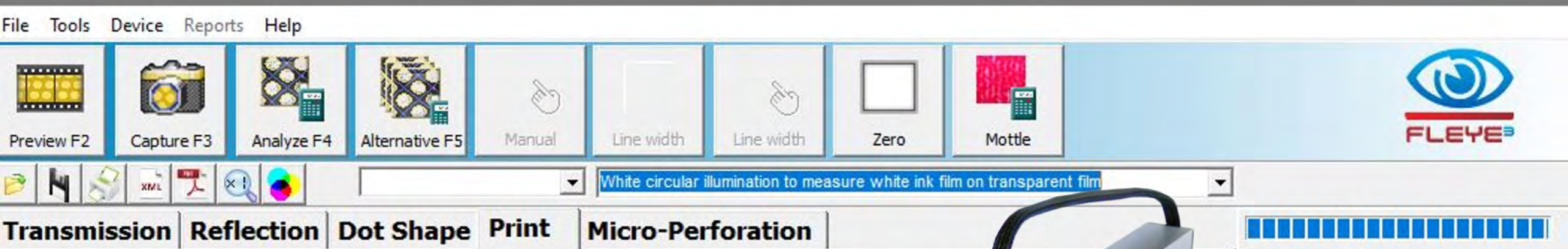


DOUBLE WHITE



Opacity measurement does not indicate the smoothness or uniformity of the ink laydown.

PINHOLE BY NUMBER: Numerical quantification of a visual defect



SOURCE: **PERET.**

PINHOLE BY NUMBER: Numerical quantification of a visual defect

WHITE POLY



SINGLE WHITE



DOUBLE WHITE



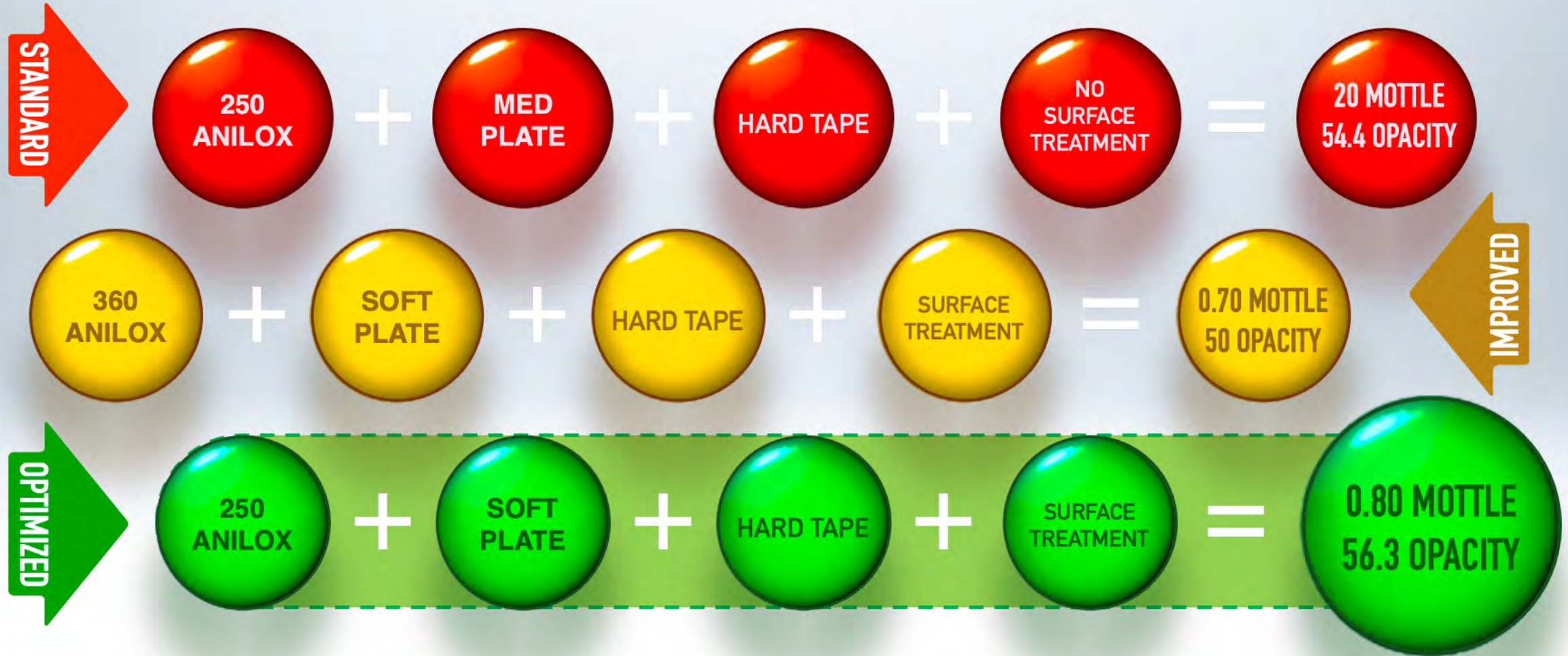
EARLY RESEARCH: Plate + Tape + Anilox + Surface Roughness

WHITE PLATE MATRIX														
SURFACE PATTERN	INK OPACITY						MOTTLE FACTOR						PLATE DUROMETER	ANILOX LPI
	MOUNTING TAPE DENSITY													
	SOFT	MED	HARD	SOFT	MED	HARD	SOFT	MED	HARD	SOFT	MED	HARD		
	NO TEXTURE			SURF. TEXTURE			NO TEXTURE			SURF. TEXTURE				
NONE	52.6	53.7	53.3	53.2	54.1	53.9	25.5	18.6	15.7	21.0	11.6	9.3	SOFT	250
	52.4	54.1	54.4	52.0	53.3	54.2	31.5	21.1	20.9	28.5	25.8	18.2	MEDIUM	
	53.5	54.7	53.5	52.8	53.8	54.2	30.0	18.3	15.3	27.3	17.0	15.5	HARD	
	49.9	51.5	51.7	50.7	52.2	53.1	28.2	19.9	11.9	22.0	11.6	7.0	SOFT	360
	49.0	50.9	51.0	49.4	50.8	51.1	36.0	26.3	28.9	37.2	29.8	25.9	MEDIUM	
	49.6	50.6	51.2	48.6	49.9	49.8	32.9	29.4	24.1	30.7	22.9	25.4	HARD	
3x3	52.6	54.1	53.8	56.3	56.0	56.3	26.7	17.8	15.4	8.8	1.6	0.8	SOFT	250
	53.0	54.6	55.2	54.9	55.3	56.0	26.1	21.0	16.7	13.8	12.7	9.0	MEDIUM	
	55.0	55.4	54.4	55.8	55.4	55.7	24.9	16.8	15.2	18.6	8.9	6.0	HARD	
	50.3	52.6	53.2	53.4	53.8	54.6	28.9	20.1	11.7	2.0	1.8	0.7	SOFT	360
	49.0	52.3	51.4	52.7	52.1	53.0	37.0	20.6	25.2	14.3	18.7	17.0	MEDIUM	
	49.8	50.9	51.4	52.5	52.8	51.5	34.2	27.0	25.3	8.6	10.3	5.0	HARD	

270

POSSIBLE COMBINATIONS WERE STUDIED & REPORTED

EARLY RESEARCH: Optimum combination for white ink transfer



INK TRANSFER PROPERTIES: Residual Loss

The ink splits & transfers when adhesion to the substrate surface exceeds cohesion within the ink & adhesion to the plate surface.

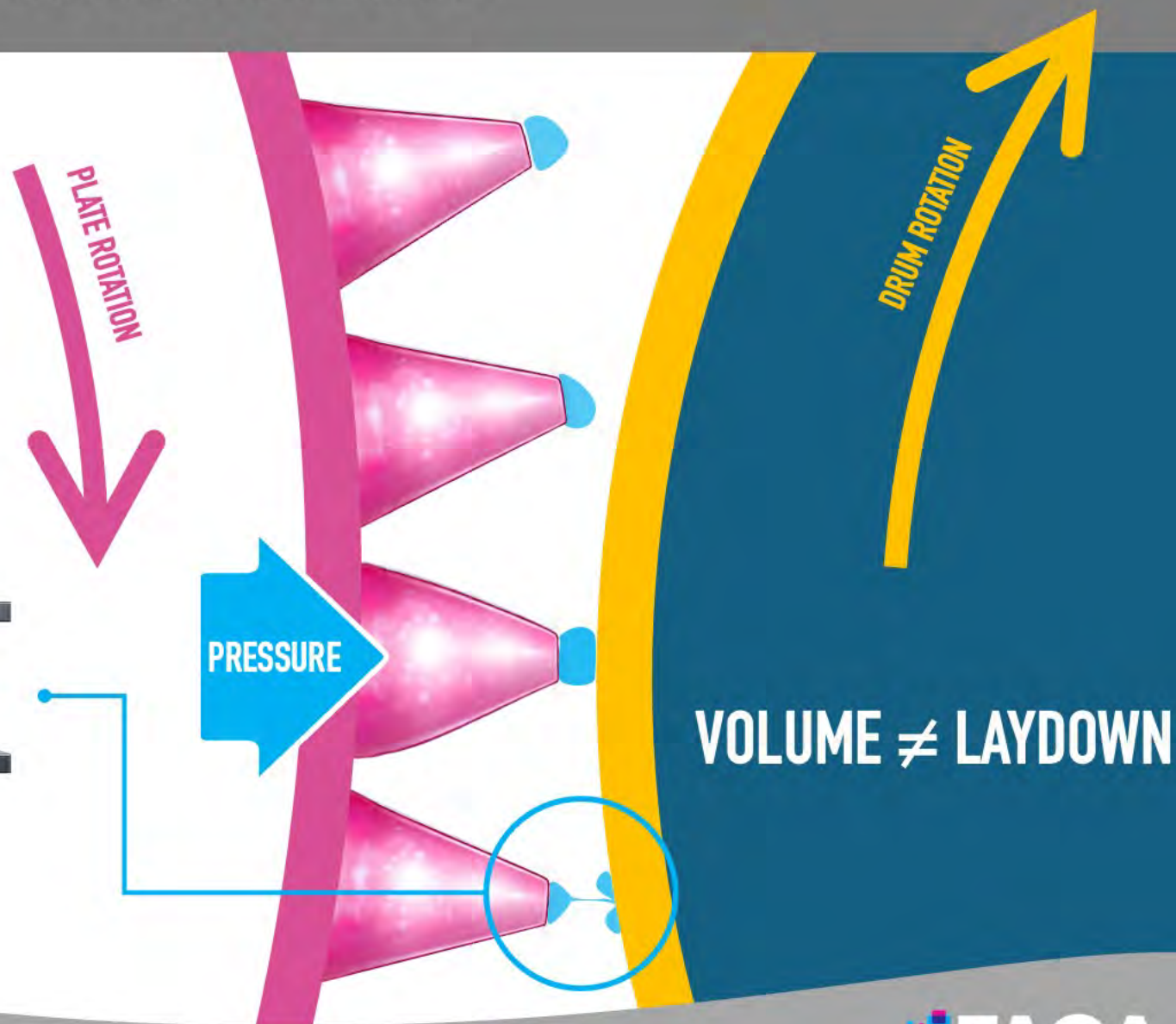
Anilox to Plate: ~60-80%

Plate to Substrate: ~30-60%

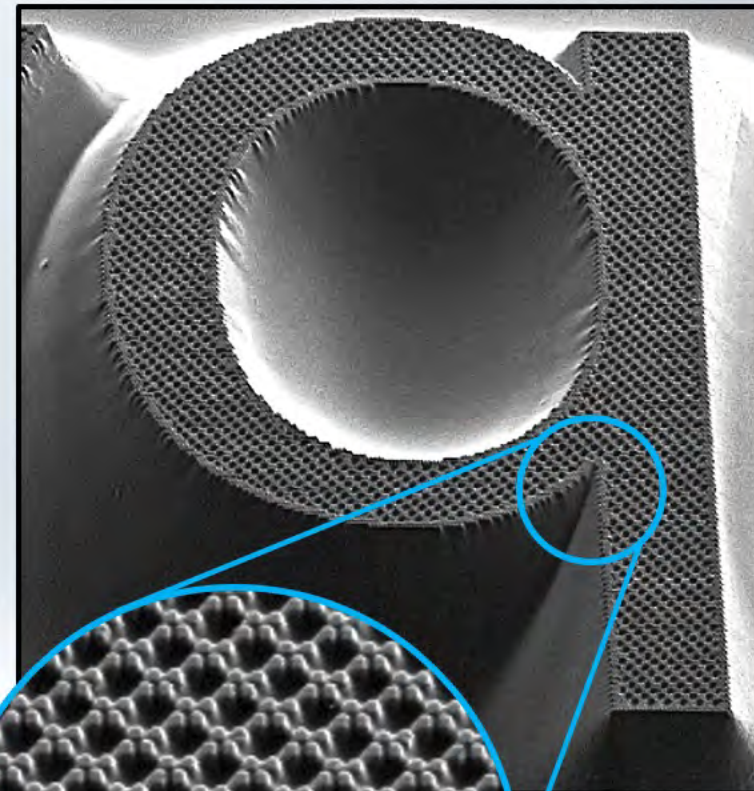
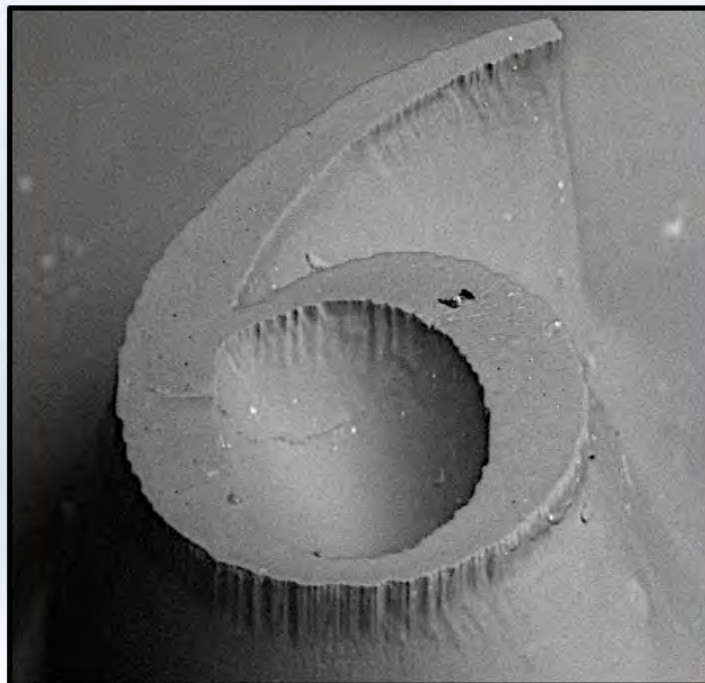
Anilox ink on the substrate: ~25-45%



* idealized thermodynamic equilibrium



FLEXO PLATE MAKING ADVANCEMENT: Beyond edge definition

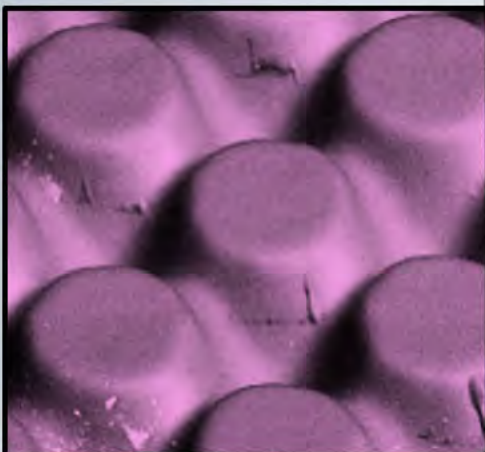


**From poorly rendered round edges of the past
to micro-engineered printing surfaces of today**

10µm

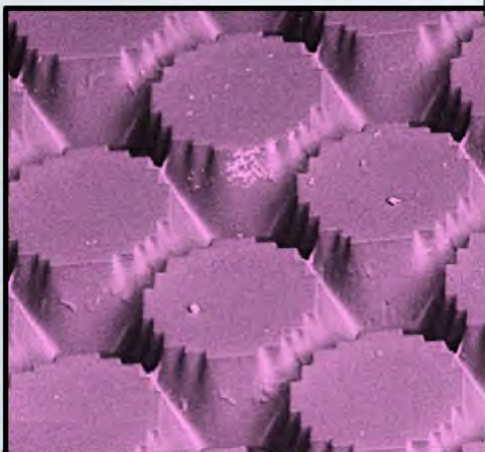
THE PROGRESSION OF UNDERSTANDING: From “bullets” to “brushes”

1996



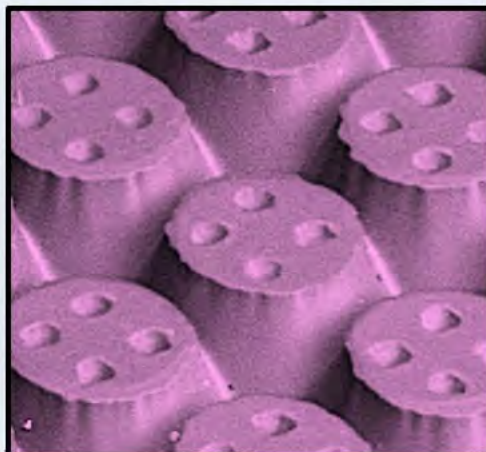
Round-tipped “eroded” dots
Laser Ablatable Mask (LAM)
Presence of Oxygen (O_2)
2540 dpi

2008



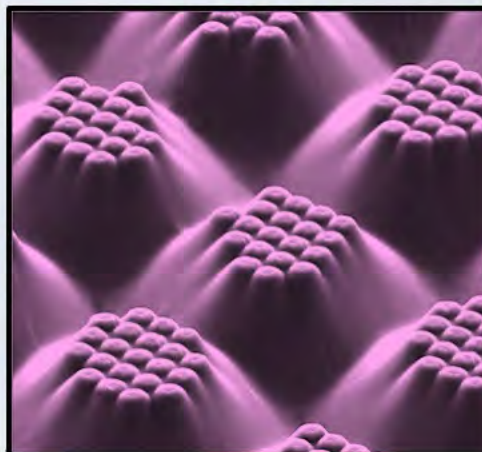
Flat-tipped 1:1 dots
Imaged & laminated film
acting as Oxygen barrier
2400 dpi

2010



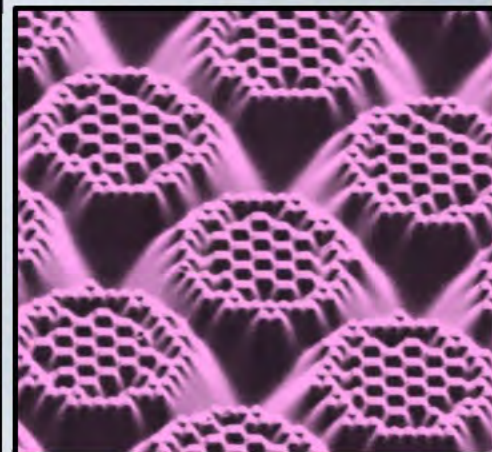
LAM + in-the-plate (ITP)
Oxygen barrier +
HD screen w / microcell
4000 dpi

2016



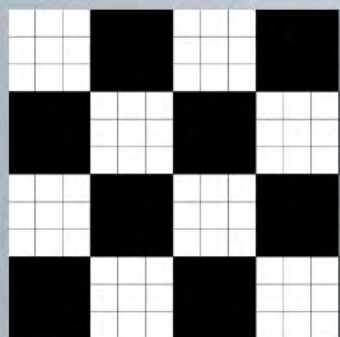
LAM + ITP Oxygen barrier
+ microcell screen pattern
4000 dpi

2021

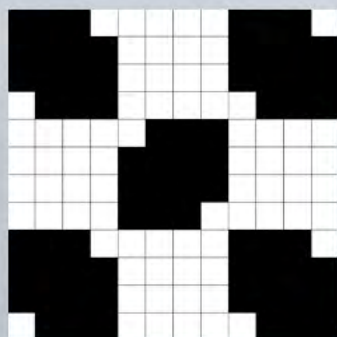


Imaged & laminated film +
advanced microcell pattern
4000 dpi

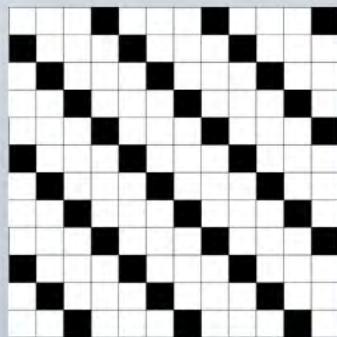
MICROCELL PATTERNS: The evolution of sizes, angles & frequencies



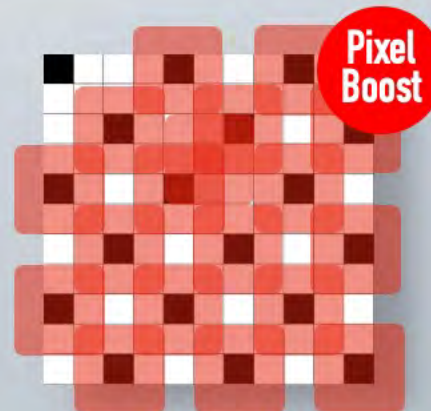
3x3



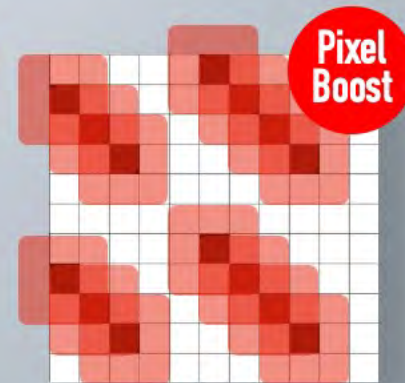
Hamillroad 8x8



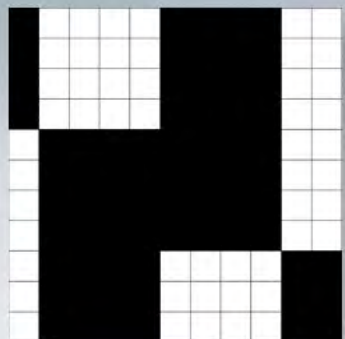
ESKO MG34



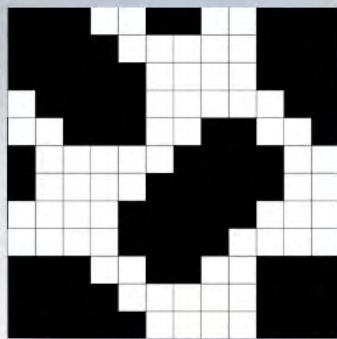
ESKO WSI



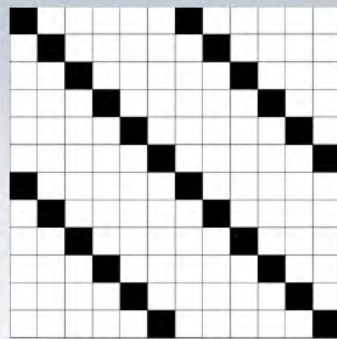
ESKO I



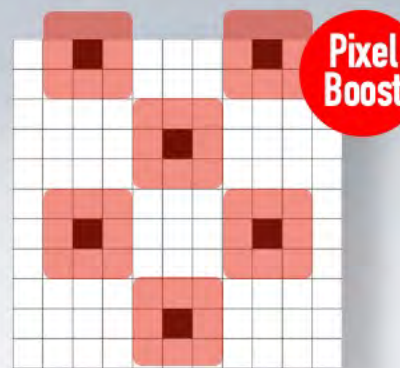
HYBRID 3



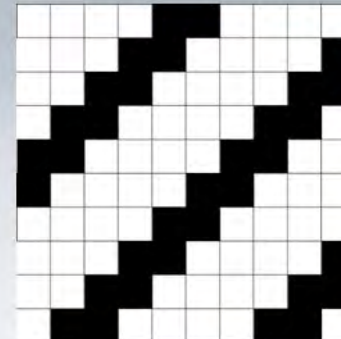
Hamillroad 9x9



ESKO MG56

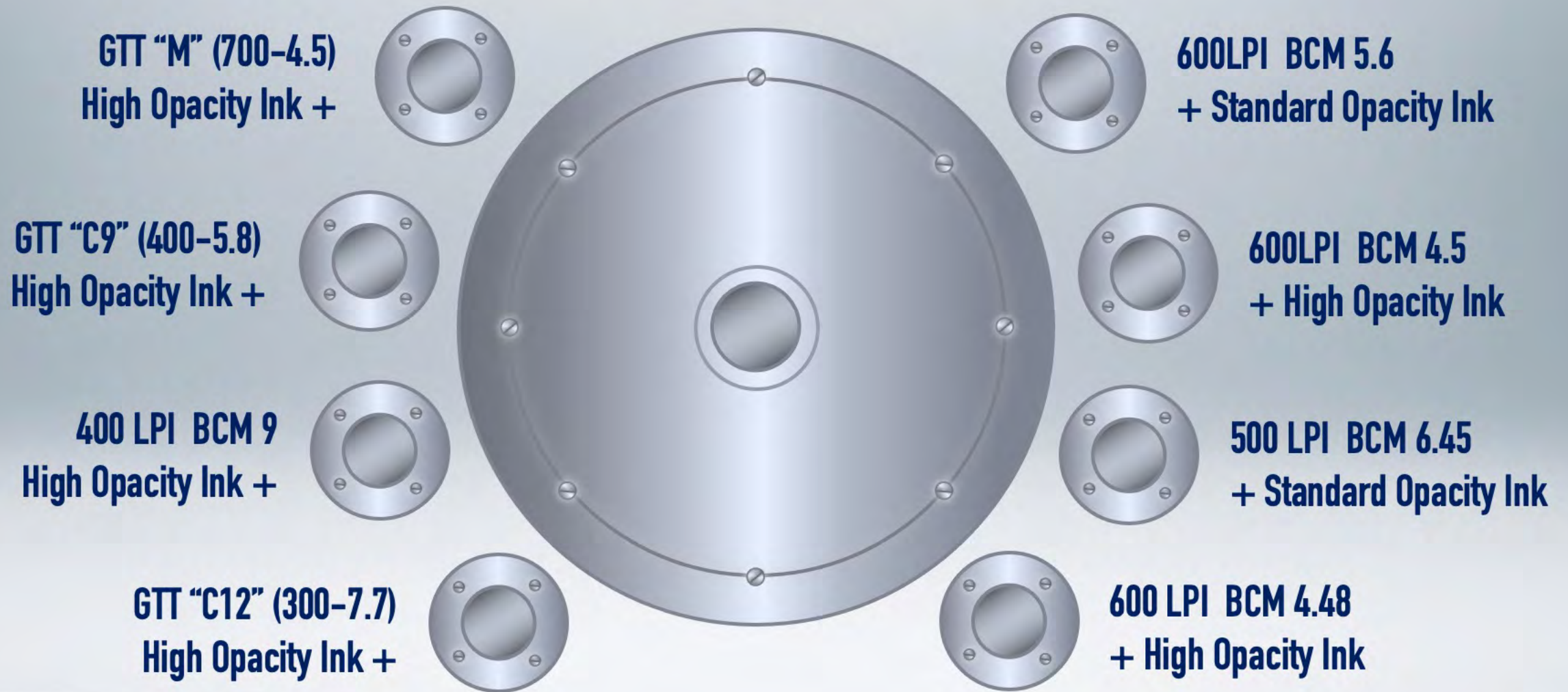


WSI WHITE



ESKO H

WHITE INK TEST → PRESS SET UP



SOURCE:





Daetwyler

x·rite
PANTONE®

Flexo
Xperience
Center

White Ink on Flexible
Film Solutions

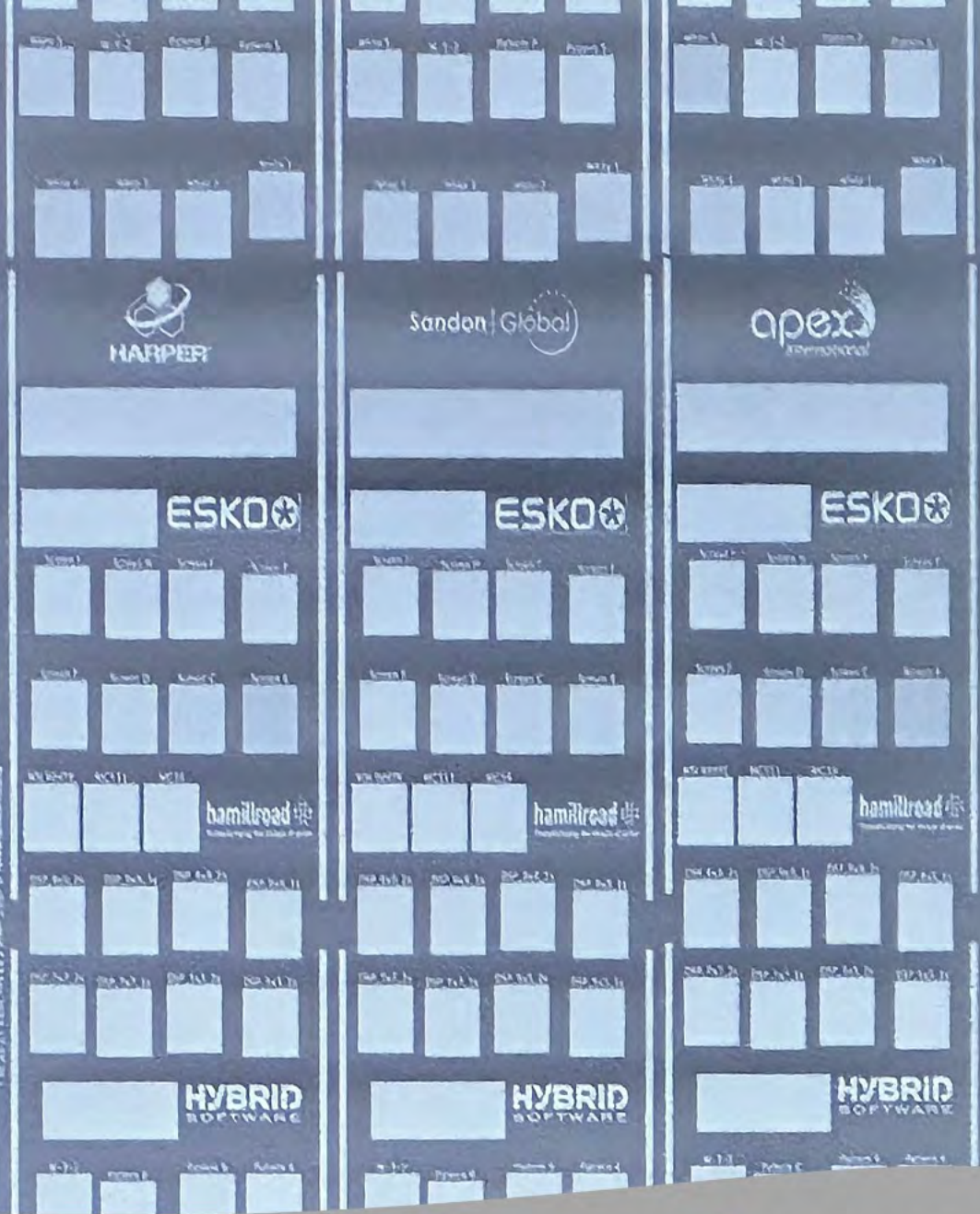
SOMA

SunChemical®
a member of the DGC group **DGC**
Color & Coatings

rotec®

Lohmann

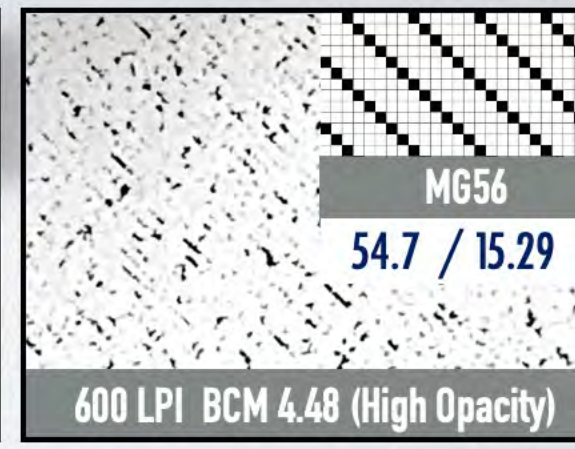
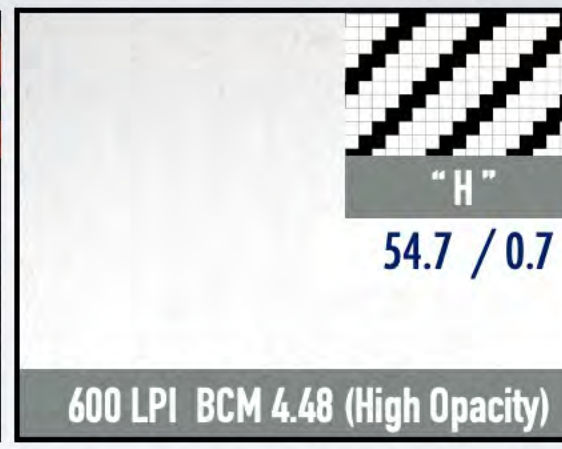
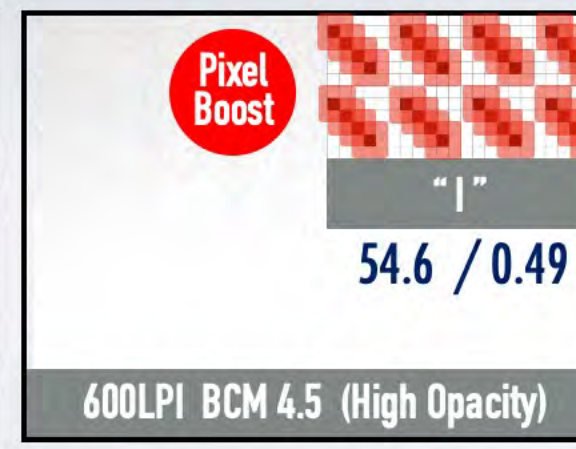
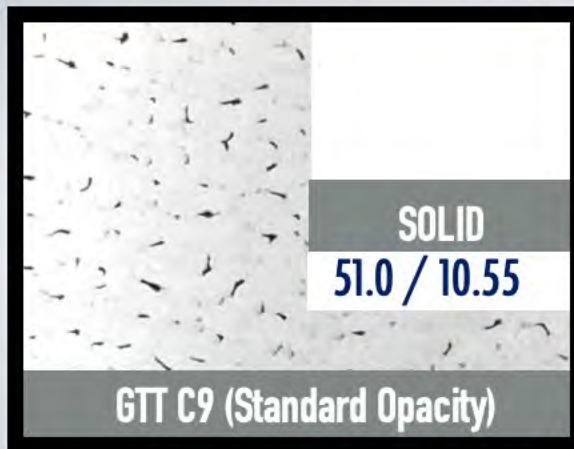
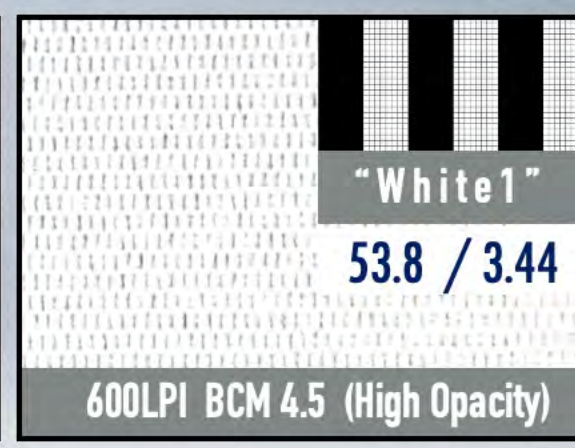
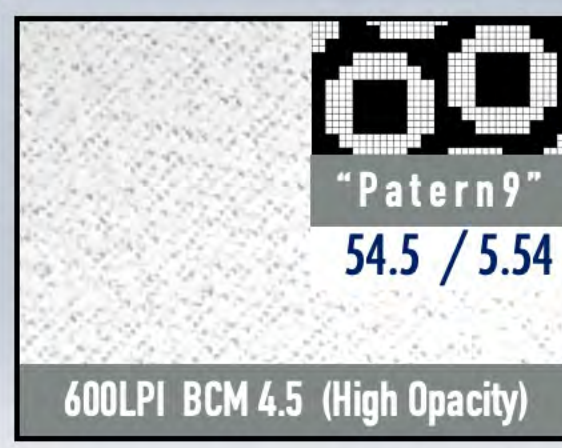
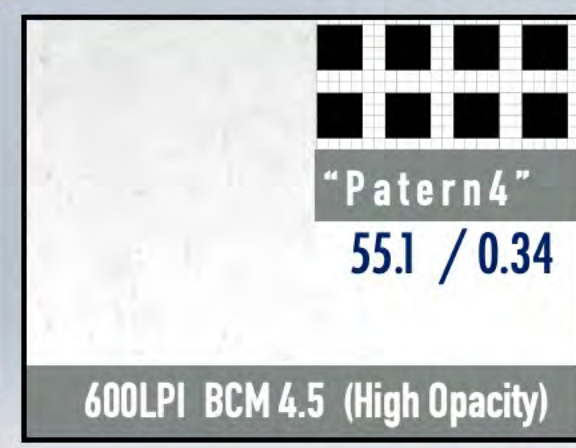
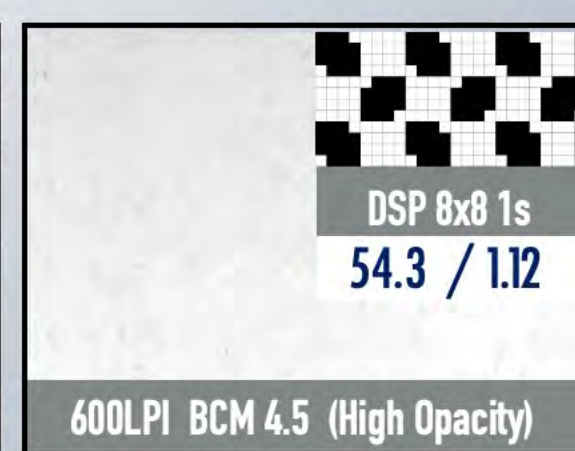
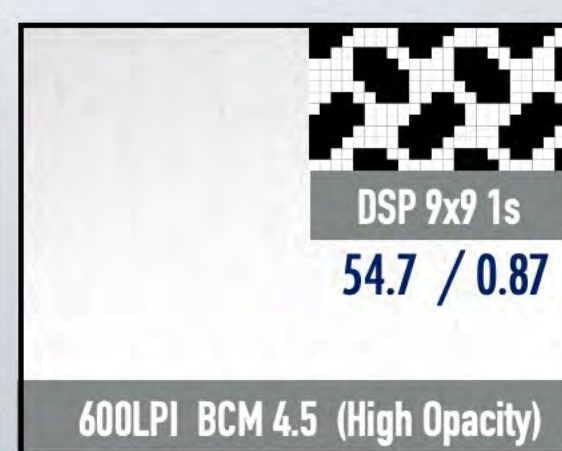
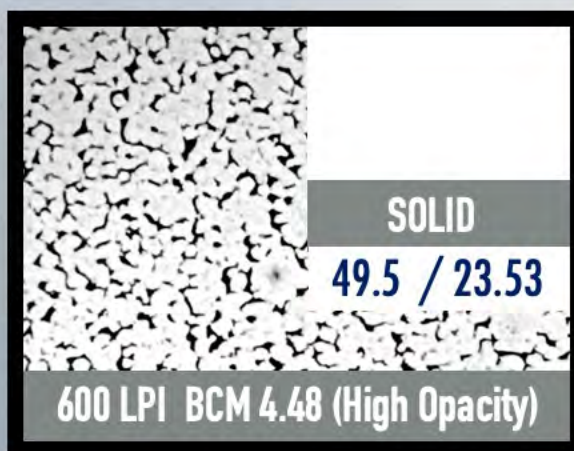
MacDermid



SOURCE:



Flexo
Xperience
Center



Pattern Name	Hi Opacity - Sandon 600 / 4.48		Hi Opacity - Harper 600 / 4.5		Hi Opacity - Apex GTT-M		Standard - Harper 400 / 5.6		Standard - Sandon 500 / 6.45		Standard - Apex GTT-C9		Pattern Maker
	Opacity (%)	Mottle	Opacity (%)	Mottle	Opacity (%)	Mottle	Opacity (%)	Mottle	Opacity (%)	Mottle	Opacity (%)	Mottle	
	49.5	23.53	52.1	19.01	49	21.22	49.8	11.09	51.4	10.57	51	10.55	
ESKO													ESKO*
Screen I	53.6	1.68	54.6	0.49	51.1	3.68	51.1	0.96	53.3	0.66	52.5	0.53	
Screen H	53.7	4.03	54.7	0.7	50.9	2.33	50.4	0.4	53.3	0.32	52.8	0.3	
Screen F	51.1	11.53	53.5	5.38	47.6	13.51	50.2	0.21	53.3	0.15	51.9	0.41	
Screen D	36.3	36.08	45.4	26.23	35.1	44.34	47.7	5.5	51.3	1.55	48.8	3.25	
Screen C	31.2	44.55	42.5	30.88	30.6	52.36	45.3	13.63	50.7	4.2	44.9	14.89	
Screen B	25.6	56.99	39.6	37.57	25.4	55.45	40.9	27.02	49.4	3.76	42.9	25.27	
MG56	52.9	15.29	54.5	5.51	53	3.07	50.9	1.67	52.6	1.43	52.3	0.8	
WSI White	45.3	17.56	53.2	2.98	49.2	10.67	50.9	0.97	53.5	0.36	52.5	0.11	hamillroad
HAMILLROAD													
MC511	54.6	0.43	55.1		53	0.56	51.5	0.74	53.4	0.57	52.7	0.44	
DSP 9x9 2s	52.3	9.9	54.3	2.89	53	1.68	51.9	0.7	53.1	0.85	52.3	0.78	
DSP 9x9 1s	53.2	4.38	54.7	0.87	51.9	3.19	51.4	0.25	53.6	0.46	52.3	1.07	
DSP 8x8 2s	52.5	6.29	54.7	4.99	52.6	1.09	51.7	0.62	52.7	1.03	52.2	0.69	
DSP 8x8 1s	52.2	2.66	54.3	1.12	51.2	0.56	50.4	0.62	53.6	0.66	52.3	0.3	
DSP 7x7 2s	52.7	12.25	54.6	2.26	52.5	2.42	51.5	0.41	52.9	1.04	52.1	0.51	
DSP 7x7 1s	53.4	3.06	54.1	0.55	51.9	3	51.5	1.27	53.3	0.22	52.1	0.52	HYBRID
DSP 5x5 2s	52.9	8.93	54.7	1.37	52.7	0.95	51.7	0.34	53.2	0.71	52.4	0.44	
DSP 5x5 1s	53	2.22	54.7	0.75	51.7	0.98	51.5	0.82	53.1	0.78	52.4	0.56	
HYBRID													
W-3-2	48.6	20.36	53.3	16.85	50	17.25	51.8	1.61	52	2.84	52.1	0.4	
Pattern 6	50.8	12.23	54.9	2.61	45.9	13.92	52.5	0.15	53.5	1.12	52.8	0.3	
Pattern 9	49.9	15.26	54.5	5.54	50.9	4.89	50.9	2.82	52	3.69	52.2	1.79	
Pattern 4	52.6	0.81	55.1	0.34	51.8	0.81	52.5	0.25	52.9	0.35	52.5	0.44	
S-2-2	52.2	12.96	54.6	2.96	52	4.49	51.9	0.94	52.8	0.8	52.4	0.49	HYBRID
WC-2-4	50.4	16.85	54.7	7.63	50.7	5.93	50.4	4.93	51.9	3.72	51.6	7.95	
Pattern 8	48.1	20.07	55	2.85	46.9	20.82	51.3	0.23	52.9	0.88	51	1.11	
Pattern 3	52.9	5.51	54.8	6.13	53.1	1.03	51.4	0.75	52.8	0.92	52.3	0.19	
White 5	38.4	46.64	42.5	36.51	39	41.1	47.6	10.94	50.5	2.25	46.2	20.21	
W-5-2	49.7	22.28	51.6	21.67	50.3	18.23	50.7	4.86	51.6	4.09	51.9	3.11	
Pattern 7	50.2	17.42	52.1	12.62	50.1	7.32	51.3	4.94	53	2.4	52	5.37	
Pattern 5	49.7	17.01	52.3	10.07	49.4	9.52	49	0.67	51.3	0.22	50.1	1.87	
White 4	49.2	22.5	51.3	12.25	46	22.26	49.5	2.86	51.2	2.87	50	3.71	
White 3	51.1	17.04	53.4	2.92	48.8	12.59	50.1	8.27	52.3	3.24	51.2	6.78	
White 2	47.3	22.94	51	12.48	46.3	10.87	50.8	1.65	52.2	1.19	51.4	2	
White 1	48.3	21.64	53.8	3.44	51.2	5.42	48.1	7.94	51.1	3.77	48.8	4.34	

IMPROVED WHITE LAYDOWN = reduced cost & VOC

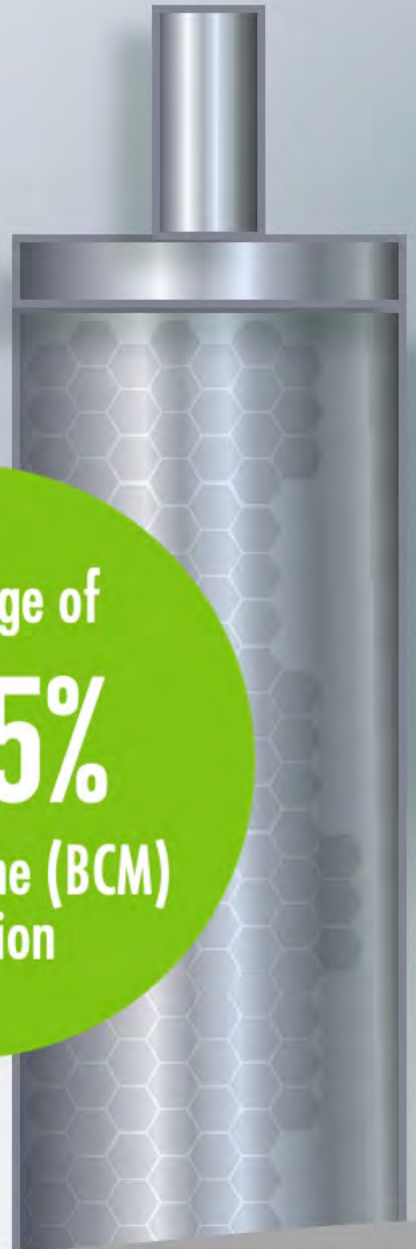
Adding **15%** more
anilox volume
provided only **1.5%**
opacity increase

Average
Flexo ink transfer
is **22-24%** from
plate to substrate
Surface screening
Can increase this
rate closer to **30%**



New reduced
anilox volume
ranging from
4.5 – 5 BCM
vs. historic
7-10 BCM
volumes

An Average of
37.5%
Anilox Volume (BCM)
Reduction



SOURCE:

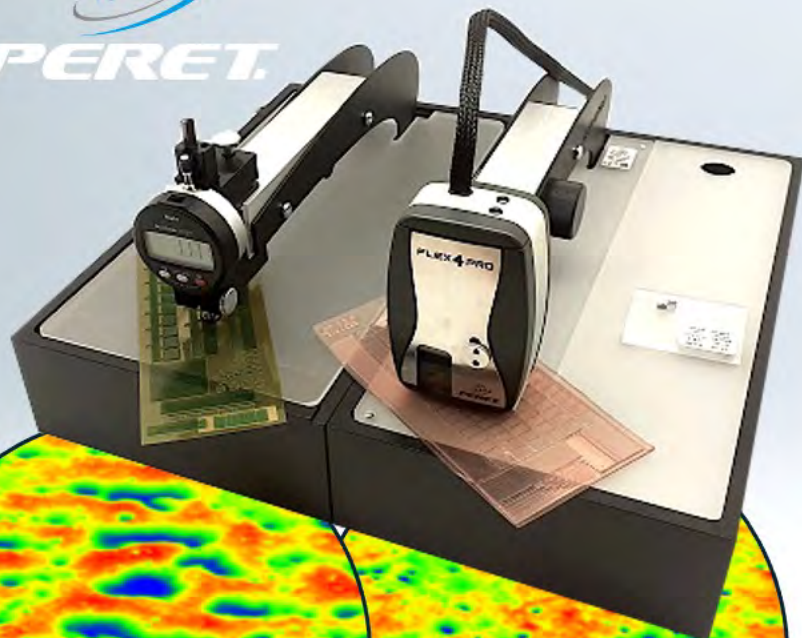


THE EVOLUTION CONTINUES: Maximizing impact through analytics

Advances in plate technology and surface engineering have simplified technology selection, but data-driven optimization is what makes these technologies far more effective.

THE EVOLUTION CONTINUES: Maximizing impact through analytics


PERET



MicroDynamics 3DQC

Parameter	Value	Unit	Target	Unit
Overall	0.14	mm	0.15	mm
W. Surface	0.14	mm	0.15	mm
W. Depth	0.14	mm	0.15	mm
W. Flatness	0.14	mm	0.15	mm
W. Roundness	0.14	mm	0.15	mm
W. Straightness	0.14	mm	0.15	mm
W. Parallelism	0.14	mm	0.15	mm
W. Perpendicularity	0.14	mm	0.15	mm
W. Angularity	0.14	mm	0.15	mm
W. Position	0.14	mm	0.15	mm
W. Orientation	0.14	mm	0.15	mm
W. Form	0.14	mm	0.15	mm



SOURCE: PERET • MICRODYNAMICS • TROIKA

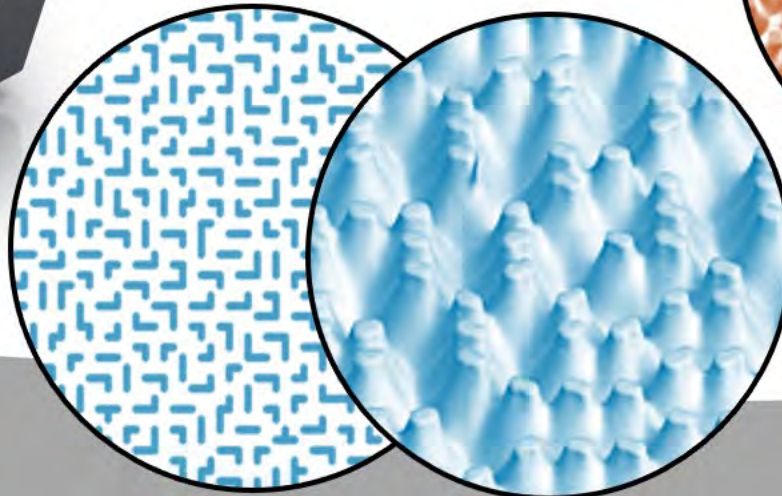
THE EVOLUTION CONTINUES: The next wave of plate technology

Today's FLEXO: pinhole-free solid coverage, low dot gain, smooth tonal transitions, microscopic details, while maintaining high-speed print, substrate and ink versatility, sustainability and print economy at scale.

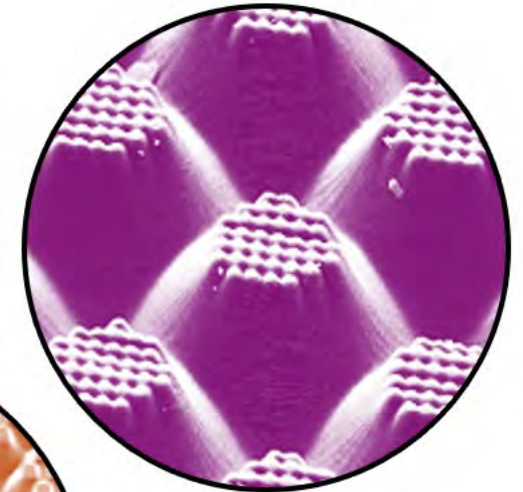
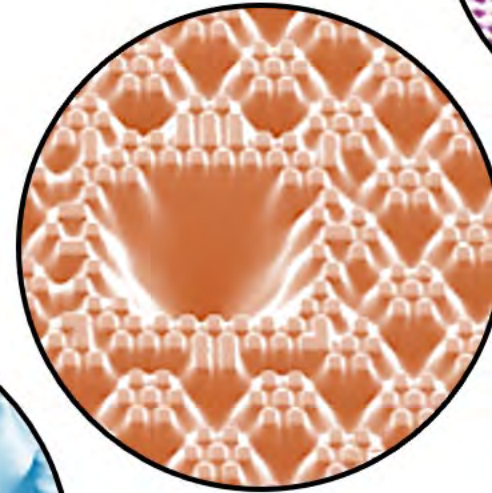
ESKO 



hamillroad 
Transforming the image of print



XSYS
Print solid. Stay flexible.



miraclon

FLEXO vs. GRAVURE: New Reality



rapid deployment & fast set-up
mission efficient
evolving, innovative & adaptive
hi-tech & automated

inefficient for short runs
expensive tooling
matured, innovation plateau
limited digital workflow integration



Thank You

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