PRINTING STRUCTURAL COLOUR

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https://cfpr.uwe.ac.uk

C F P R

C R E A T I V I T Y A N D I N N O V A T I O N

C F P R

MANY THANKS TO

SUSANNE KLEIN
HARRIE FULLER, ABIGAIL TRUJILLO VAZQUEZ

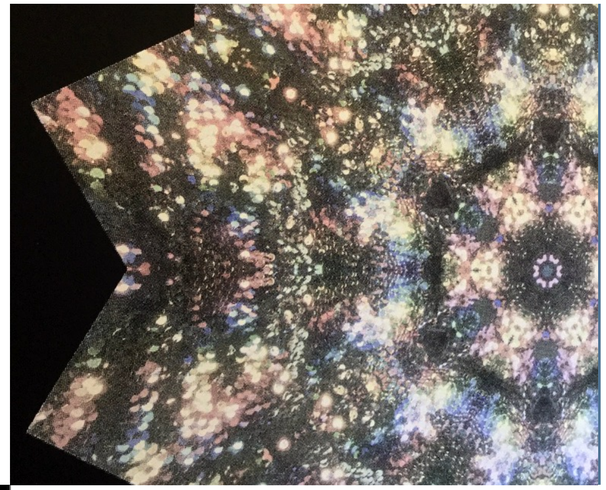
CENTRE FOR PRINT RESEARCH
UNIVERSITY OF THE WEST OF ENGLAND, BRISTOL, UK

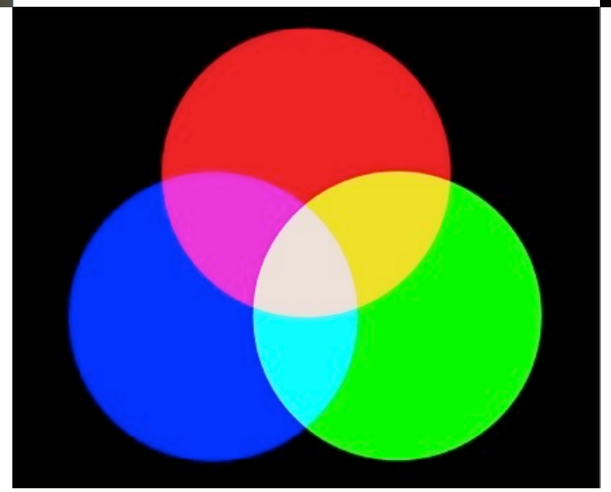
UWE Bristol University of the West of England

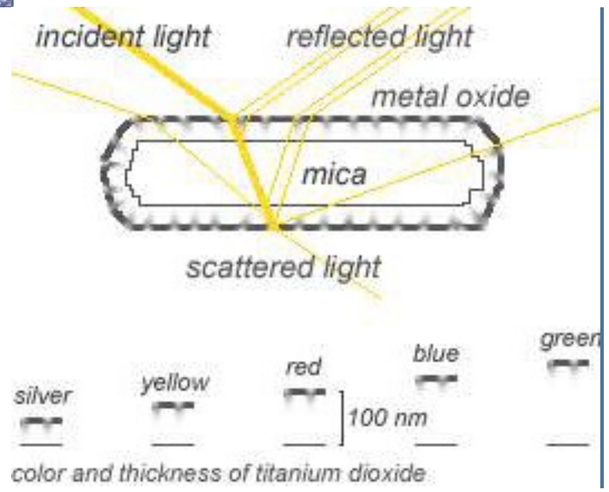
UKRI Research England

RGB COLOUR PIGMENT PRINTING

Pigment colour printing on black paper, mimicking the mixing of coloured light, that affords the potential to reproduce structural colour, such as beetles, shells and feathers.







Merck Spectraval™

OTHER RESEARCH ON RGB INKS

Alina Pranovich and Abıgaıl Trujıllo Vazquez

Dot Off Dot Screen Printing with RGBW Reflective Inks

Angular dependent reflectance spectroscopy of RGBW pigments

Advances in Printing and Media Technology, Vol. XLVIII(VIII) – Session 2B, 19–24

Journal of Imaging Science and Technology R67(3):030404-1–030404-6,2023. Society for Imaging Science and Technology 2023

Alina Pranovich, Sasan Gooran, Sergiy Valyukh, Daniel Nyström, Linköping University, Sweden
Jeppe Revall Frisvad , Technical University of Denmark
Abıgaıl Trujıllo Vazquez, Harrie Fuller Carinna Parraman, Susanne Klein, University of the West of England

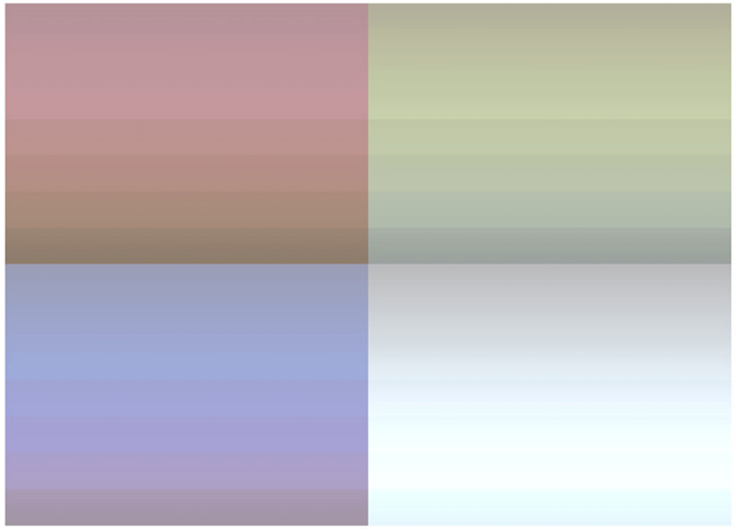


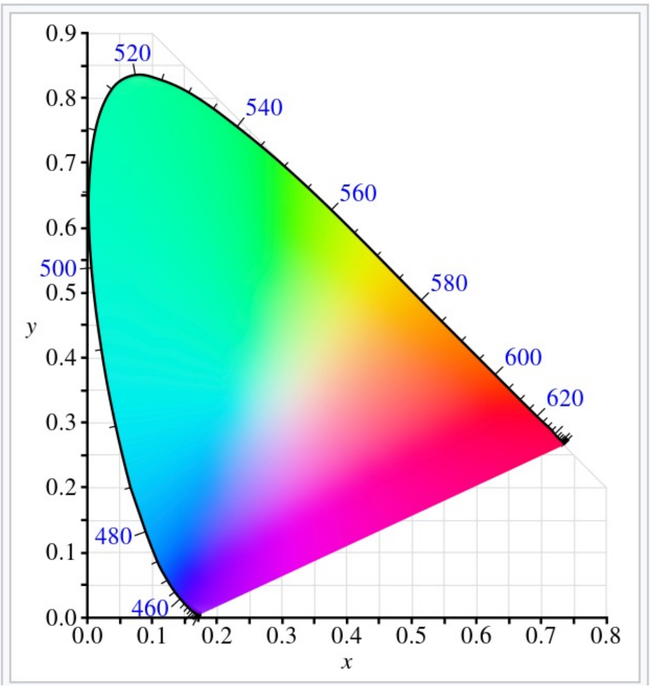
Figure 6. RGBW primaries appearance under diffuse illumination.

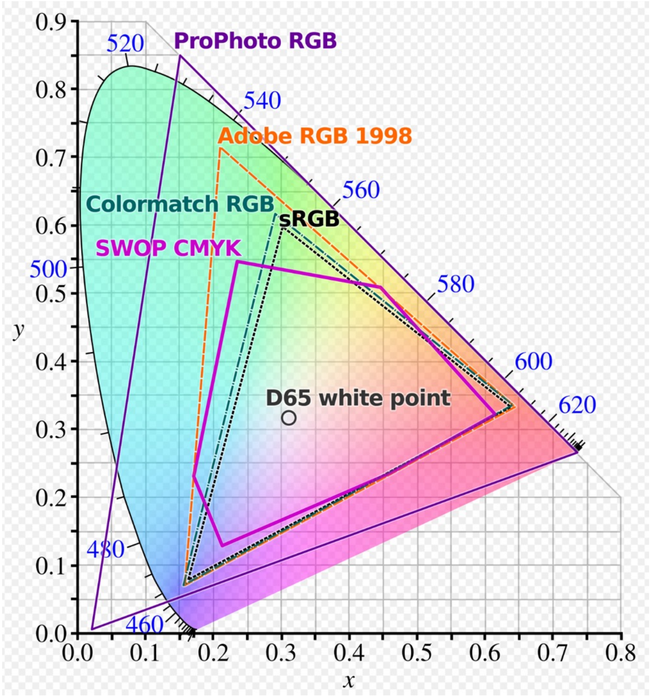
Pranovich et al.: Dot off dot screen printing with RGBW reflective inks

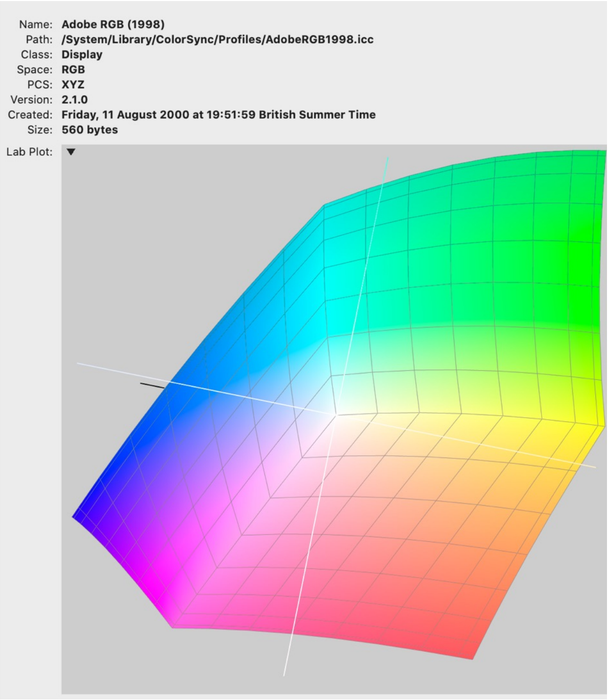
Figure 5. Measured (left) and calculated (right) RGB values of halftoned patches of combinations of primaries under 30° illumination and observation angle. Top to bottom: RG, GB, RB and RGB.

ApPEARS
APPEARANCE PRINTING
European Advanced Research School

G A M U T


520
540
560
580
600
620
500
480
460
y
x


ProPhoto RGB
Adobe RGB 1998
Colormatch RGB
sRGB
SWOP CMYK
D65 white point
520
540
560
580
600
620
500
480
460
y
x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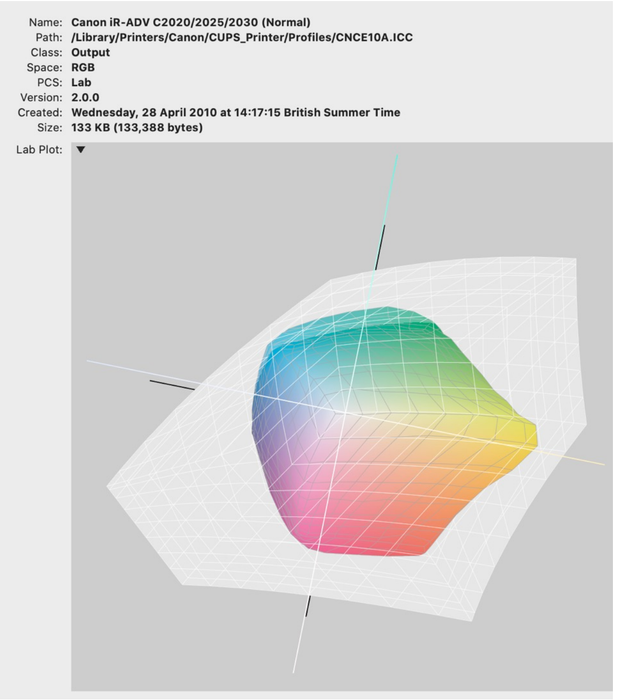
Space: RGB
PCS: XYZ
Version: 2.1.0
Created: Friday, 11 August 2000 at 19:51:59 British Summer Time
Size: 560 bytes
Lab Plot: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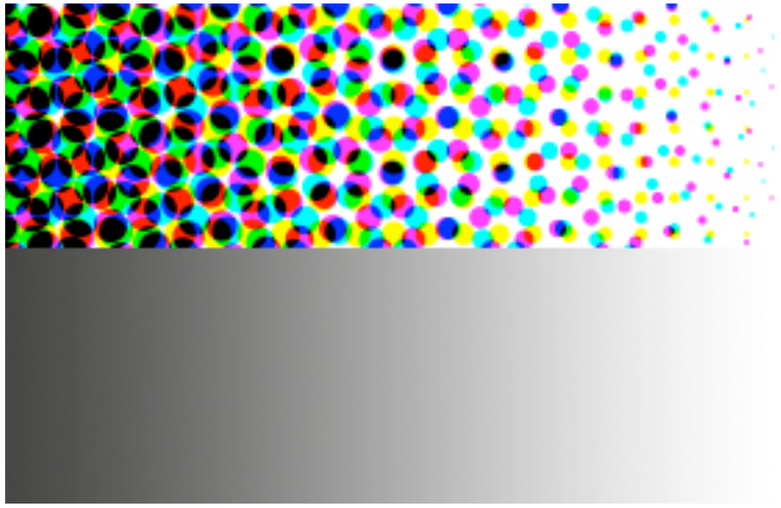
Path: /Library/Printers/Canon/CUPS_Printer/Profiles/CNCE10A.ICC
Class: Output
Space: RGB
PCS: Lab
Version: 2.0.0
Created: Wednesday, 28 April 2010 at 14:17:15 British Summer Time
Size: 133 KB (133,388 bytes)
Lab Plot:

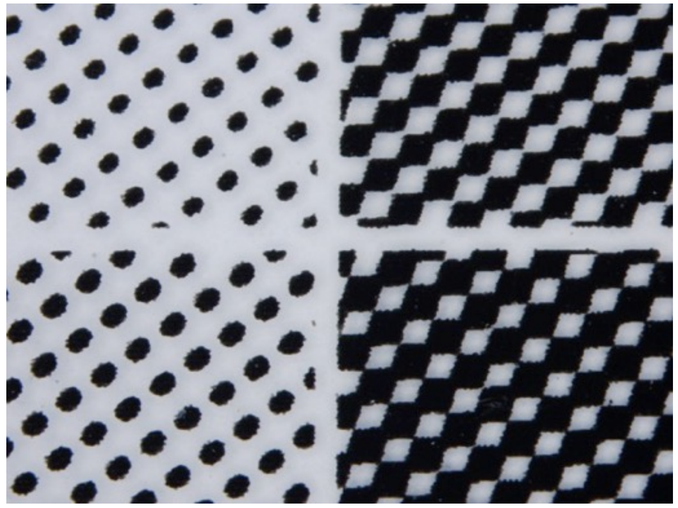
2D PRINTING

COLOUR HALFTONING

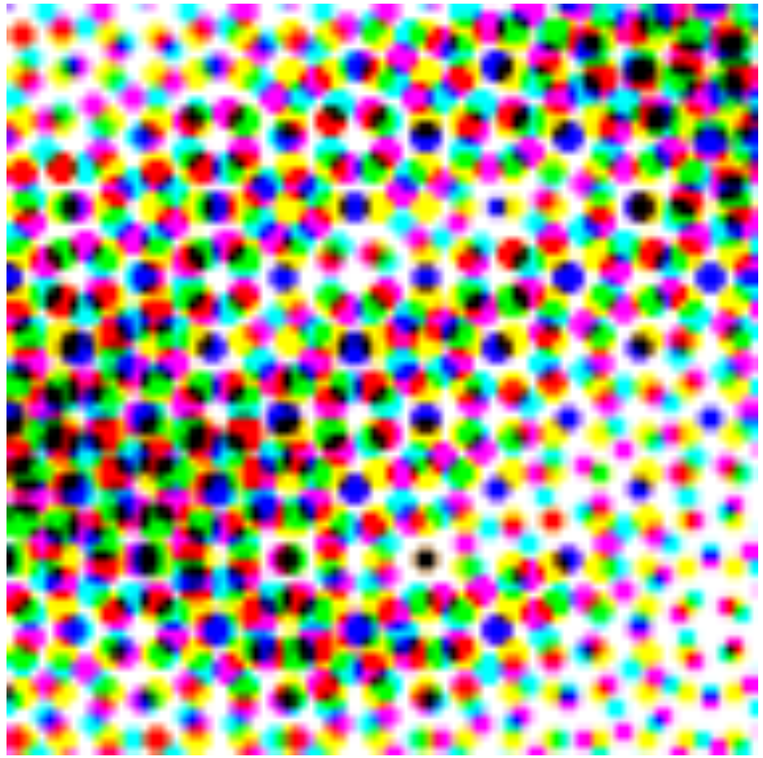
Hans Neugebauer's eight primary colours. The primary colours are (from left to right) white (of the paper); cyan, magenta and yellow; blue, red and green; black. (Illustration adapted from Viggiano 1995)

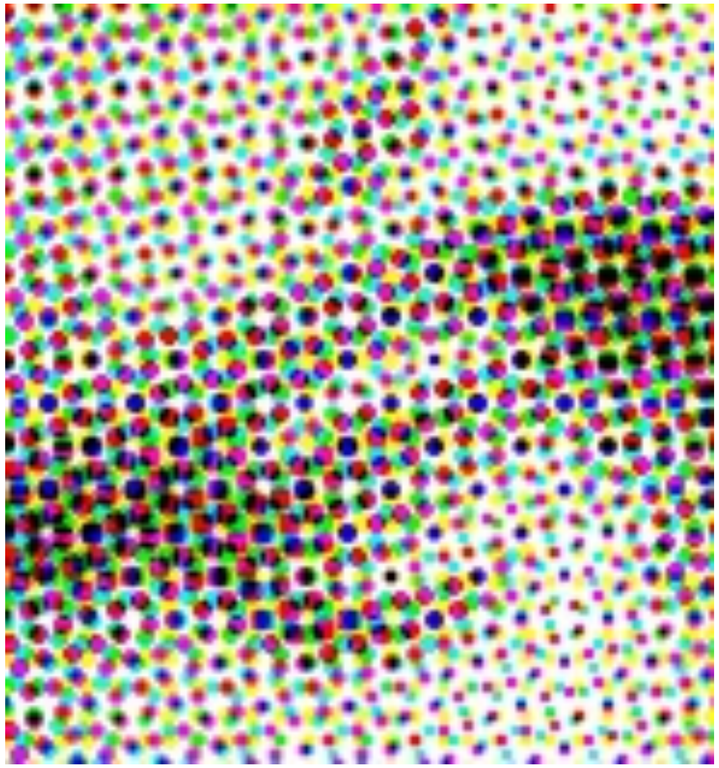


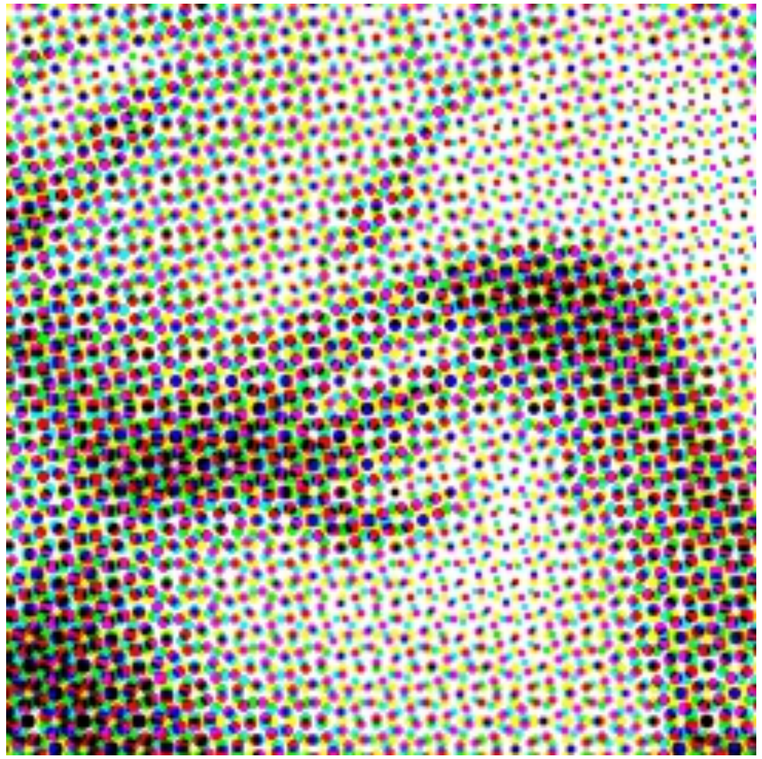
A graded grey is shown and through a simulation of printing of three process colours: cyan, yellow and magenta, onto a white paper shows the overlapping of halftone cells (top left) where equal proportions of cyan, magenta and yellow will optically mix to appear as a grey.



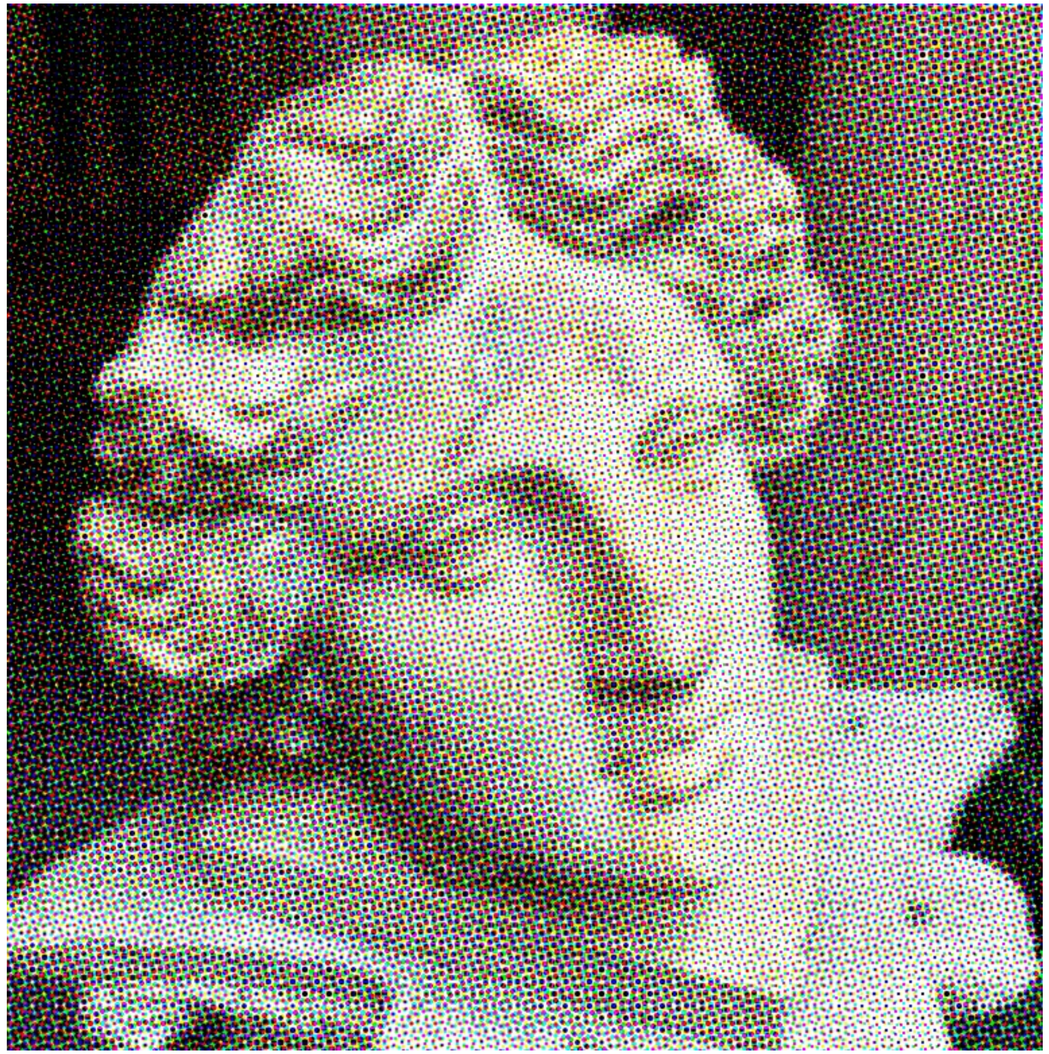
Halftone cells increasing
in percentage from light to dark
Angle of halftone or AM screen indicated above at 45°



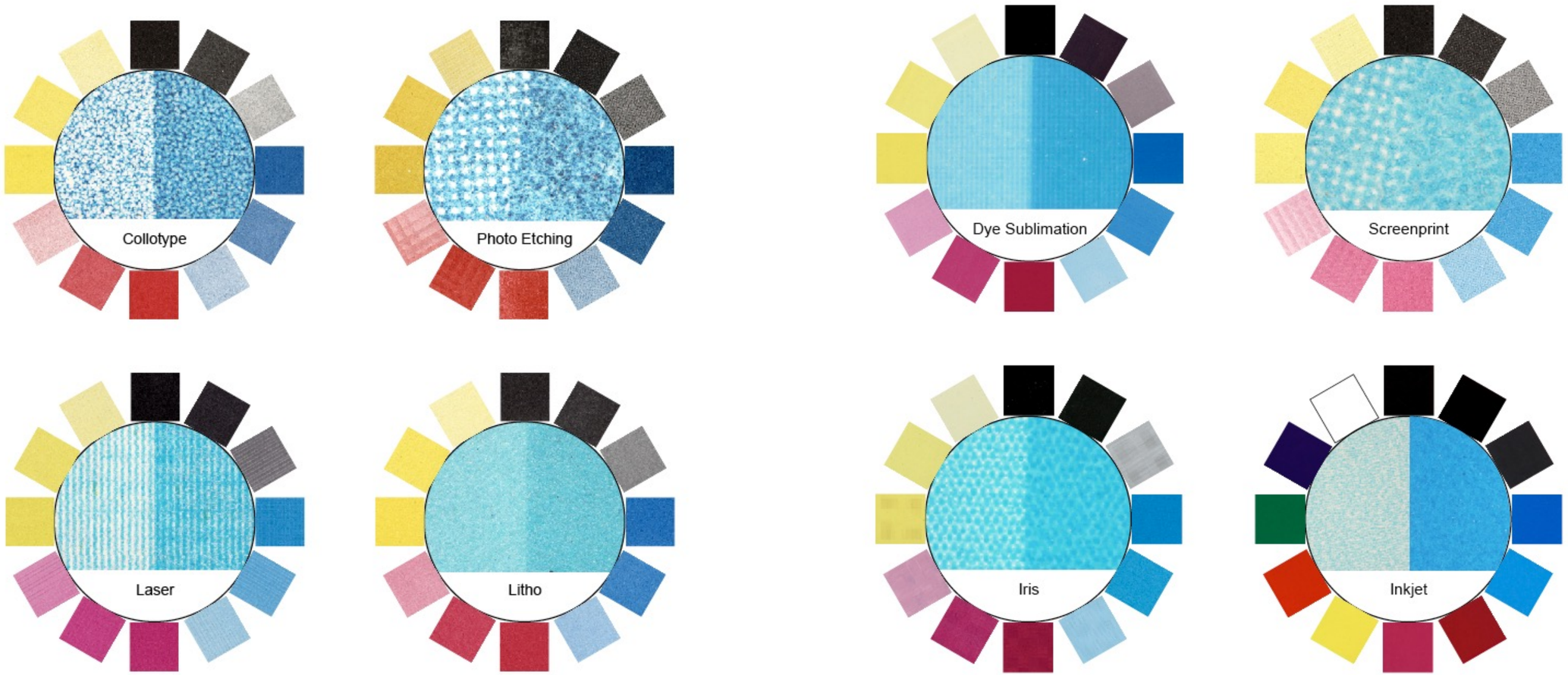




H A L F T O N I N G

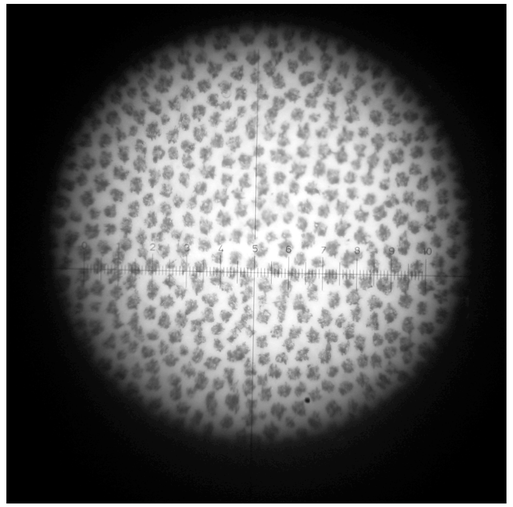


COLOUR HALFTONING

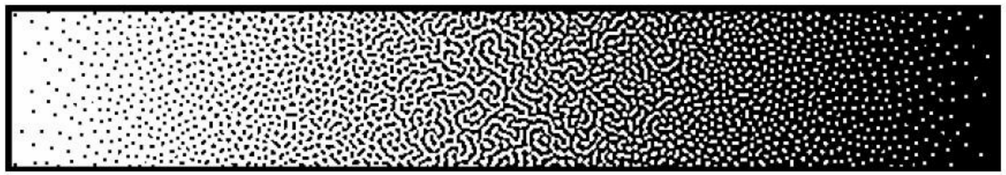


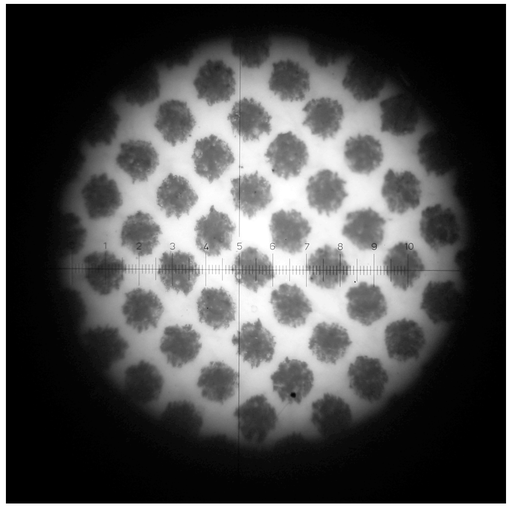
Examples of primary process colours printed at different percentages using a range of print processes.

COLOUR HALFTONING



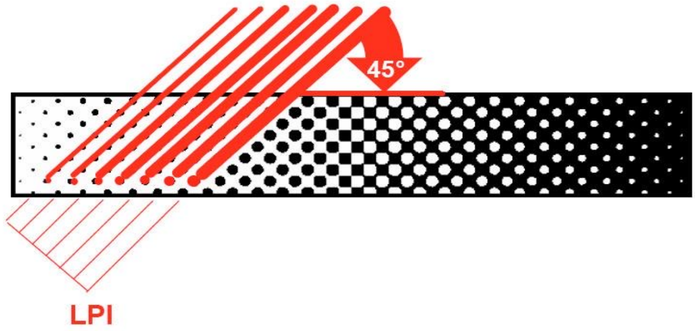
Stochastic FM screening, tightly spaced microdots
Inkjet
Randomly placed for optimal image reproduction
Many colours
Alleviates moiré





Traditional AM screening
Litho, offset, gravure
Fixed angles
4 colours
Moiré

Process Colour	Angle#1	Angle#2	Angle#3
Cyan	75°	75°	45°
Magenta	45°	15°	75°
Yellow	0°	0°	0°
Black	15°	45°	15°



RGB COLOUR GAMUT + HALFTONE PROBLEM

G A M U T

Name: **Adobe RGB (1998)**
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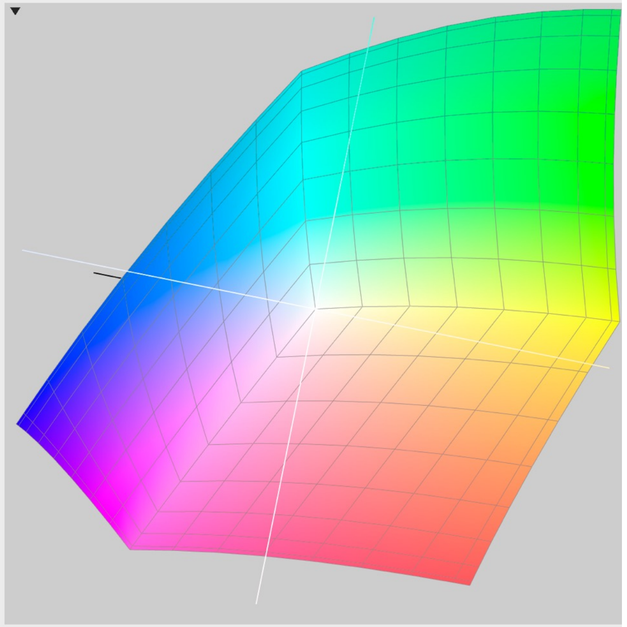
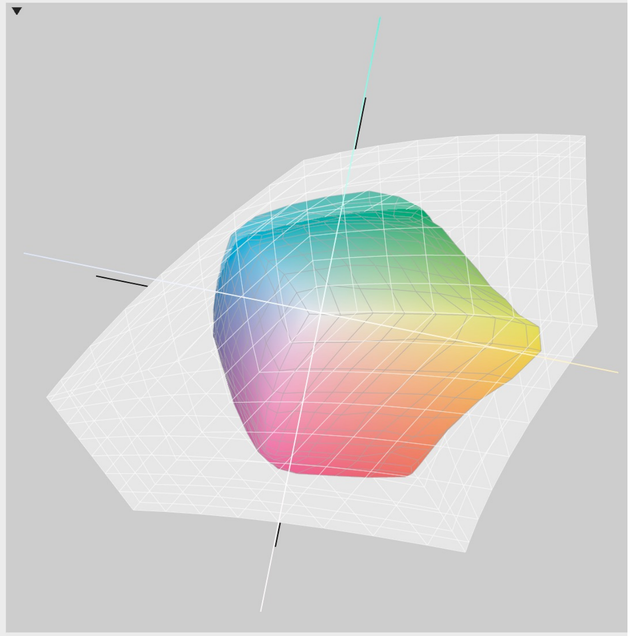
Class: **Display**
Space: **RGB**
PCS: **XYZ**
Version: **2.1.0**
Created: **Friday, 11 August 2000 at 19:51:59 British Summer Time**
Size: **560 bytes**

Lab Plot:



Name: **Canon iR-ADV C2020/2025/2030 (Normal)**
Path: **/Library/Printers/Canon/CUPS_Printer/Profiles/CNCE10A.ICC**
Class: **Output**
Space: **RGB**
PCS: **Lab**
Version: **2.0.0**
Created: **Wednesday, 28 April 2010 at 14:17:15 British Summer Time**
Size: **133 KB (133,388 bytes)**

Lab Plot:



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Space: **RGB**
PCS: **Lab**
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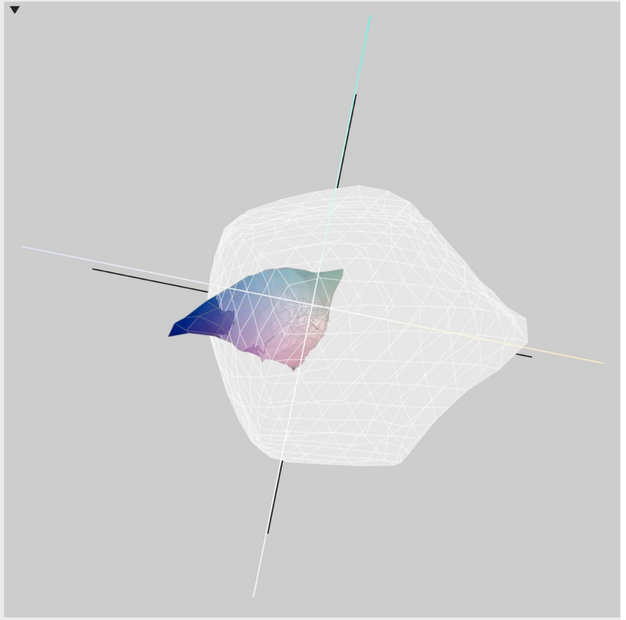
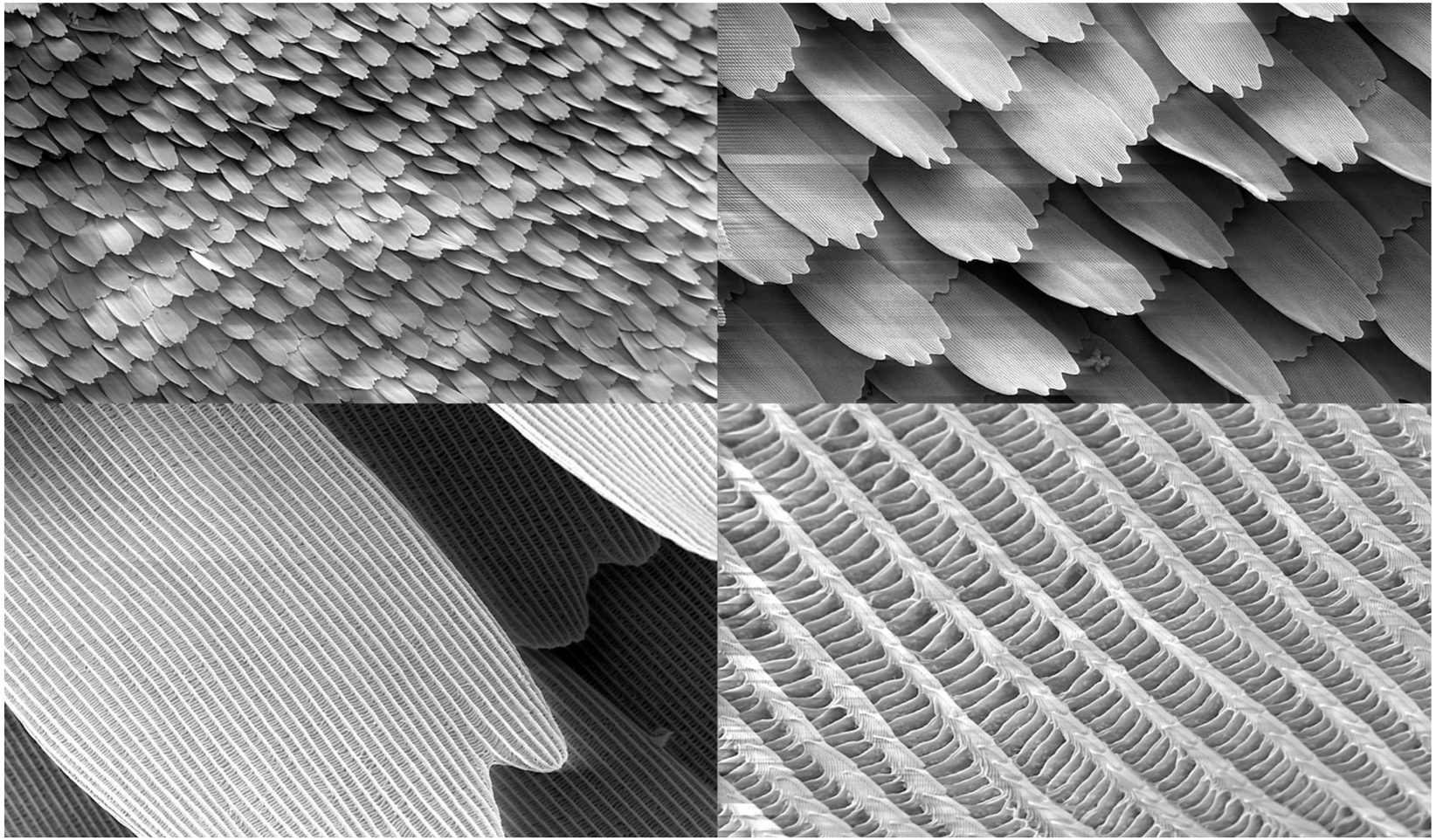
Lab Plot:

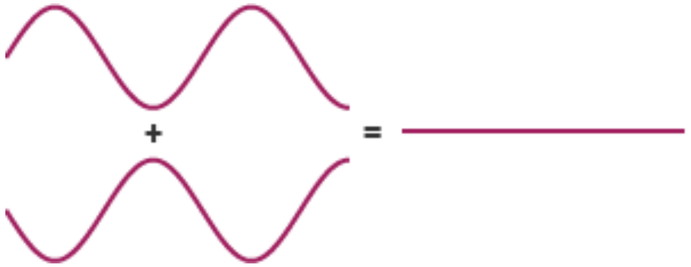


RGB PRINTING

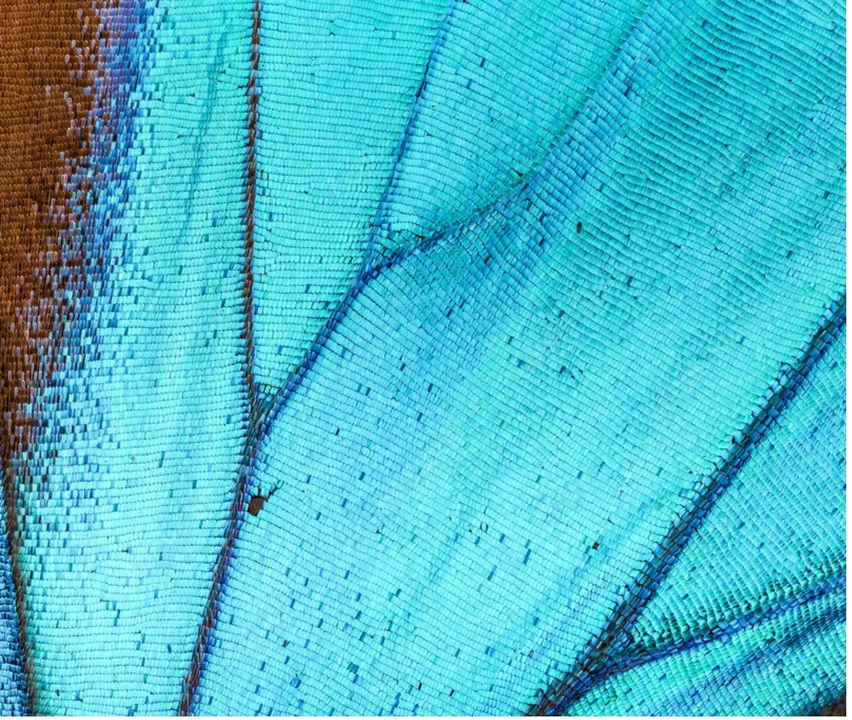


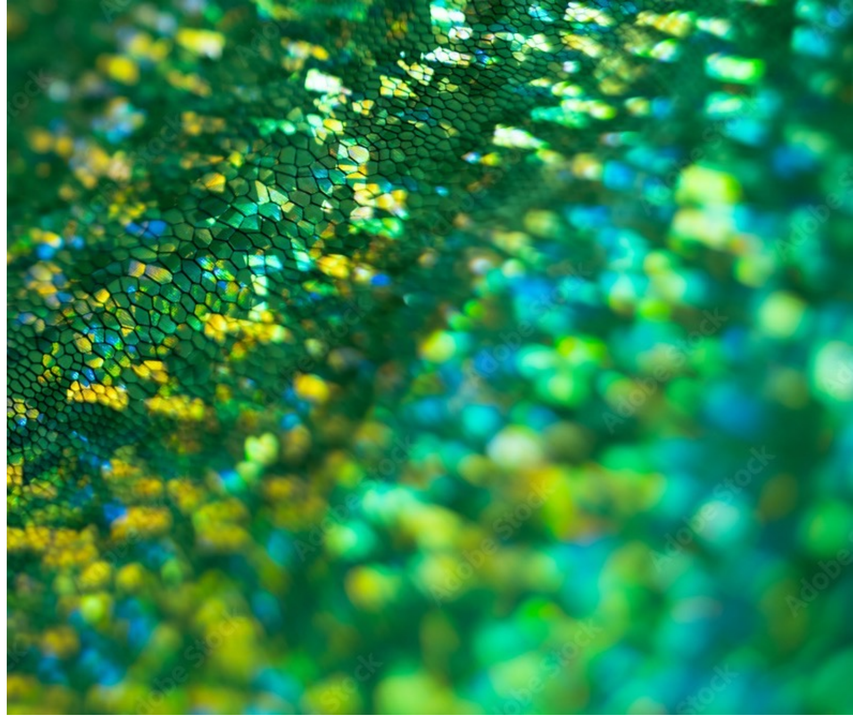
https://commons.wikimedia.org/wiki/File:SEM_image_of_a_Peacock_wing,_slant_view_1.JPG

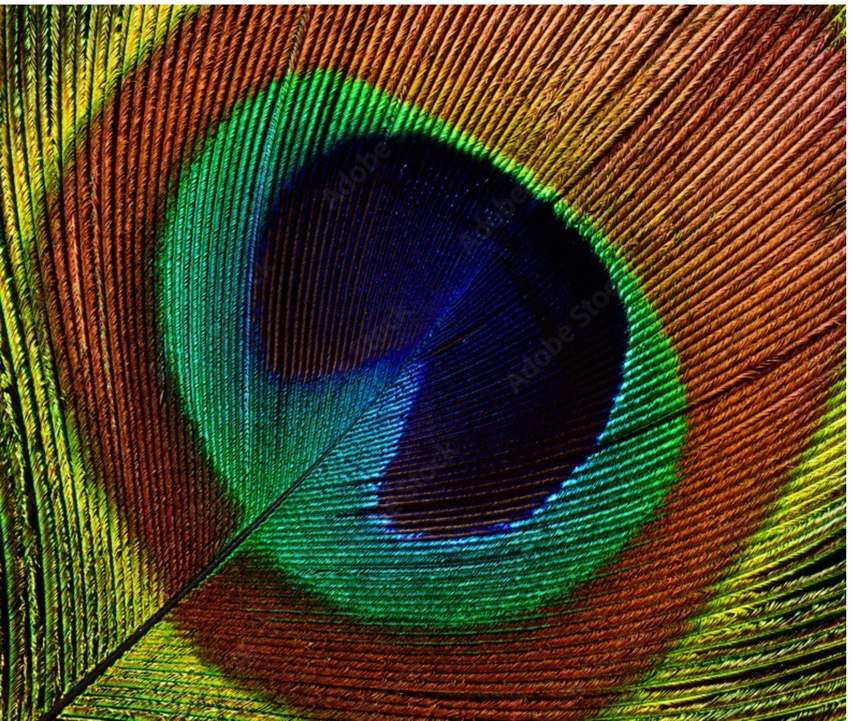
Constructive interference



Destructive interference

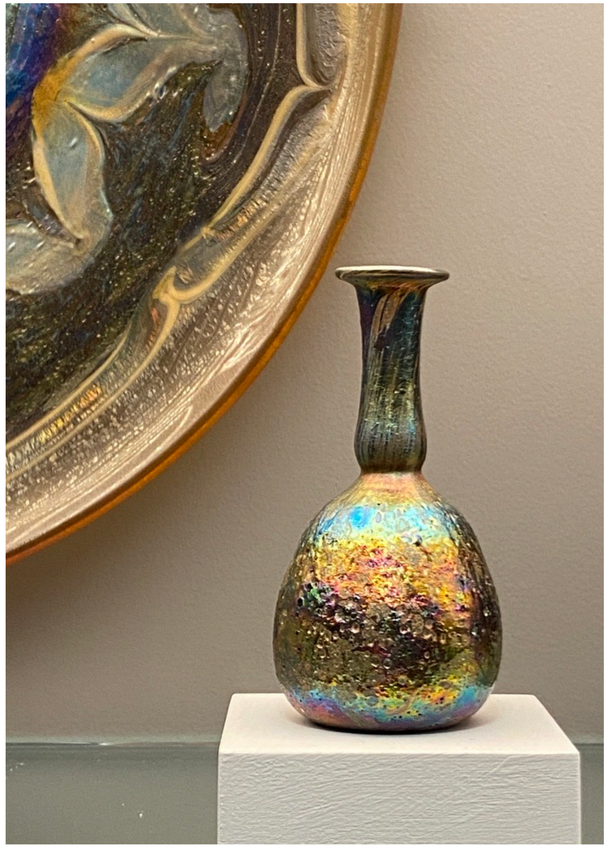


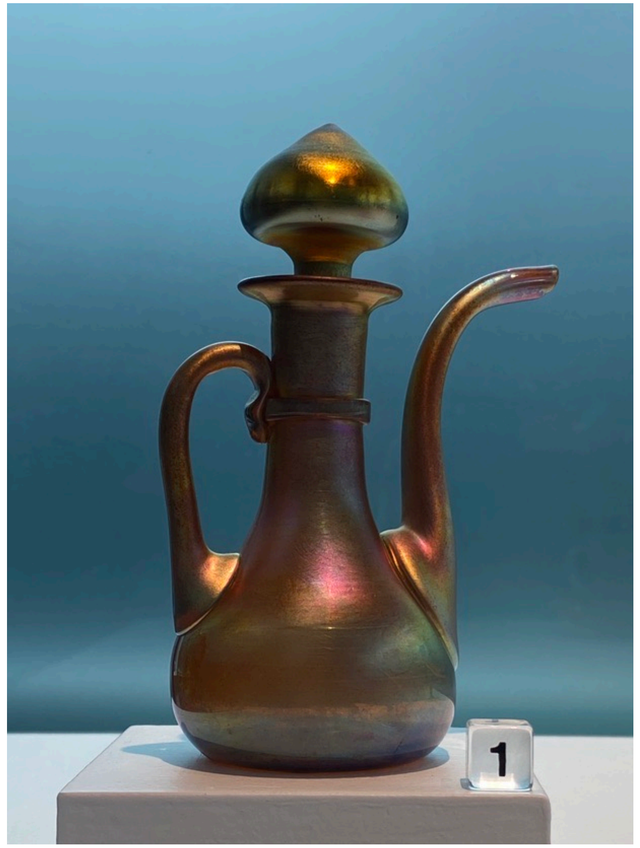





Adobe Stock | #479265095

CORNING MUSEUM OF GLASS





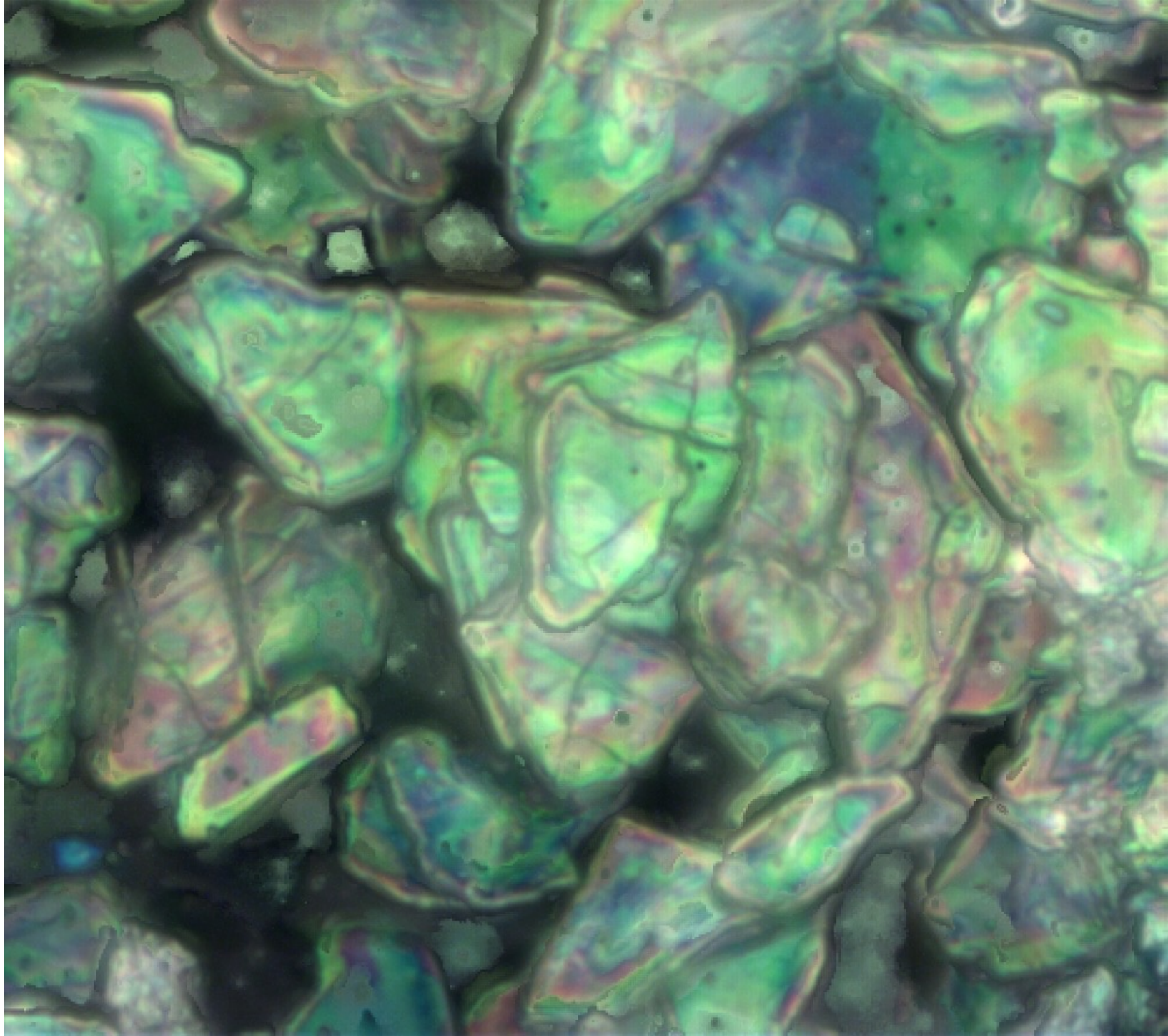
INKS UNDER OBSERVATION

The inks have different colours – green, blue and red.

Techniques used:

- Optical microscopy – using the Raman microscope camera and view sharp – this gives an enhanced depth of focus
- Fluorescence produced when the sample is irradiated with light at 532nm (Green) out to 900nm
- Raman spectroscopy using a green laser (532nm). This potentially gives chemical and structural information on the inks.

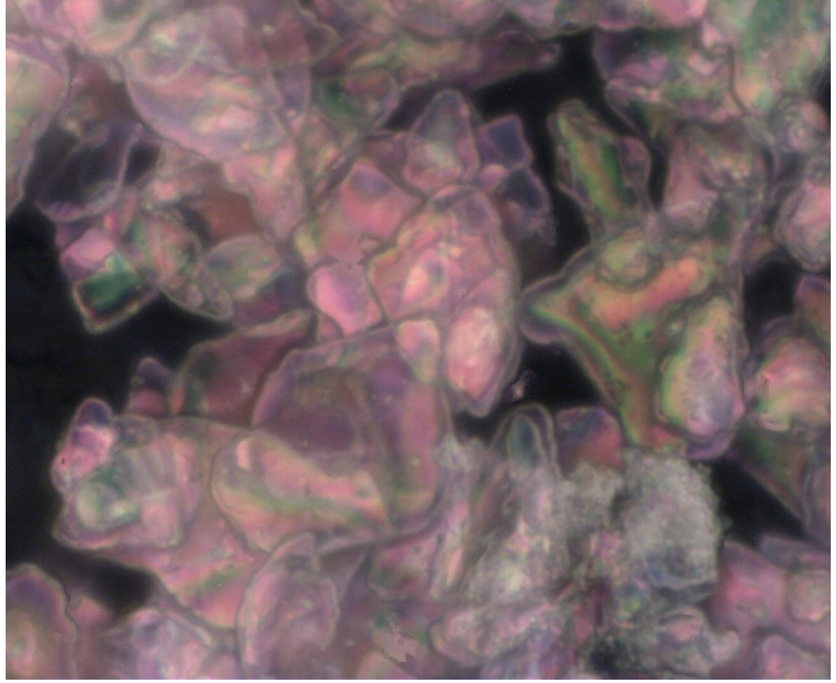
Images supplied by Tim Cox, UWE

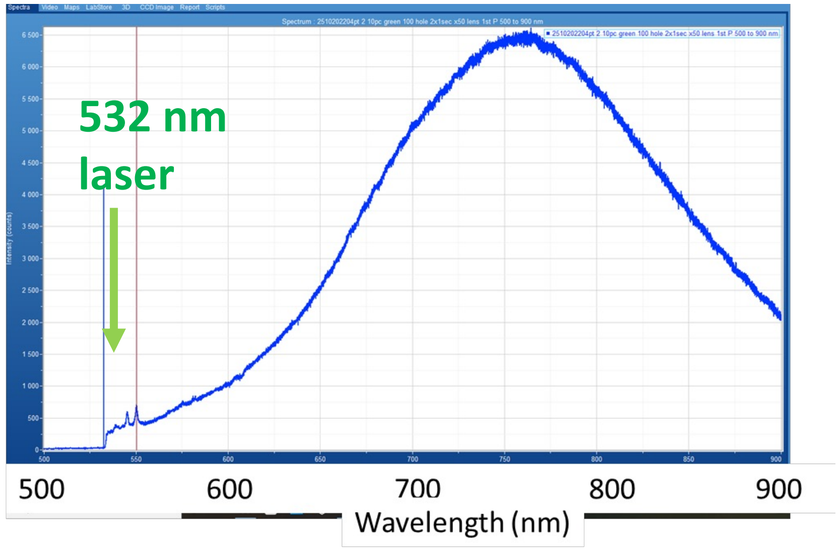


INKS UNDER OBSERVATION

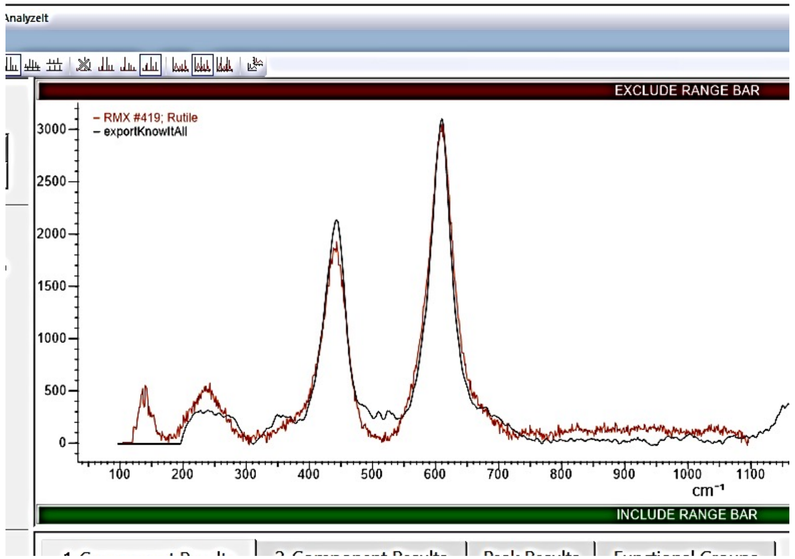
Individual ‘flat’ flakes can be seen – a few to 20 microns in size.

Flakes seem to pack and to be mostly flat

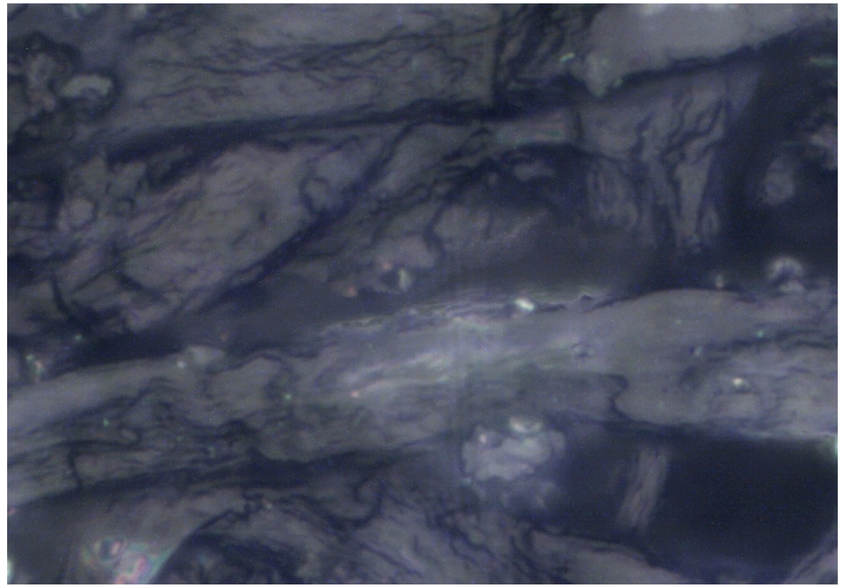




Levels of fluorescence are low with UV light



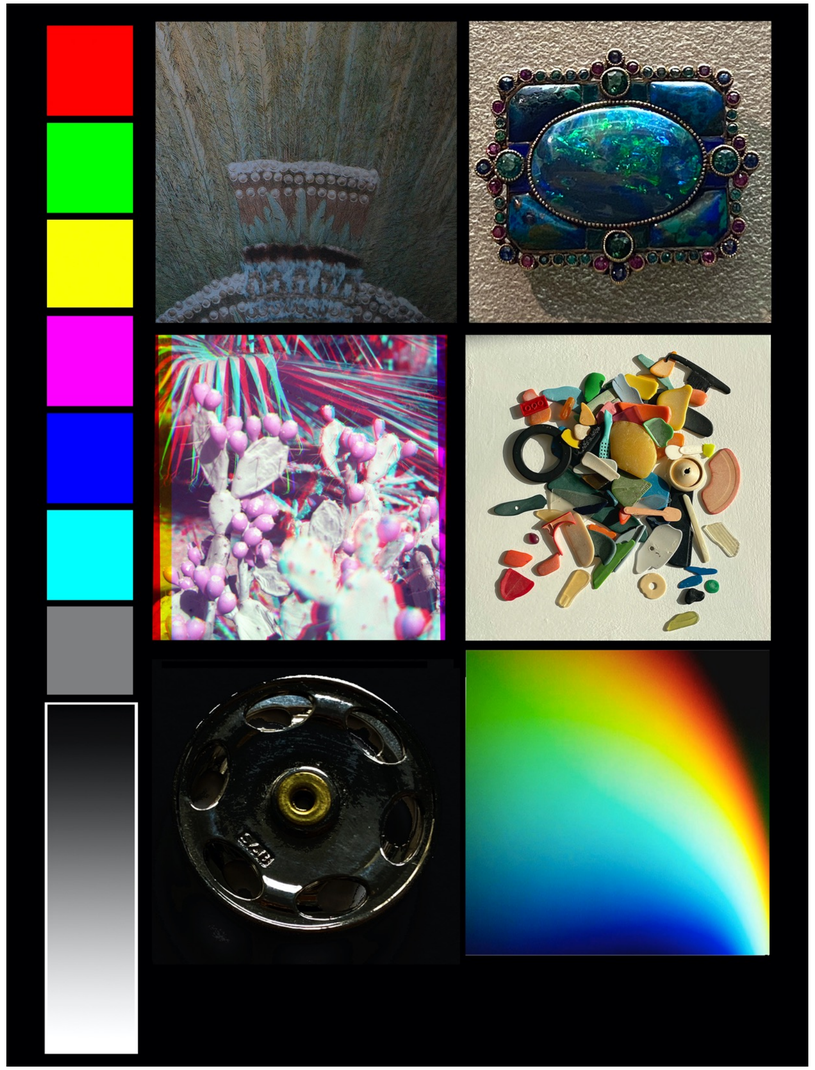
The material appears to be Titanium Dioxide



Black paper is highly calendered

PROCESS AND OUTPUT

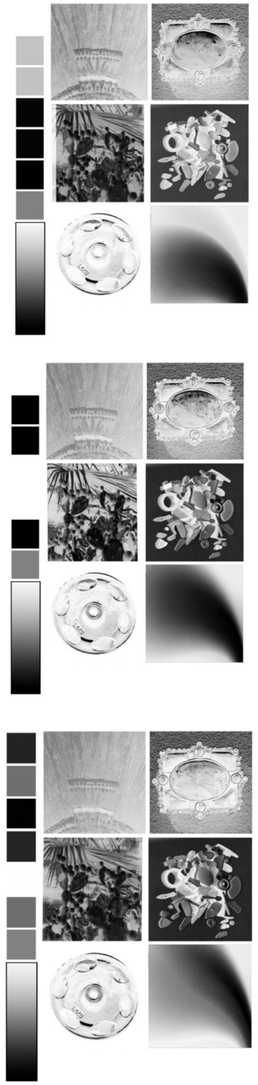
RGB Colour patches	Images (centre)	Images (right)
Red 255 Green 255 Yellow R255; G255 Magenta R255; B255 Blue 255 Cyan B255; G255	Mexican headress made of feathers	Opal piece of jewellery
Grey R126; G126; B126	RGB photograph generated by RGB filters	Plastic items collected from the beach
Grey scale 0 – 255	Metal disk	Colour spectrum

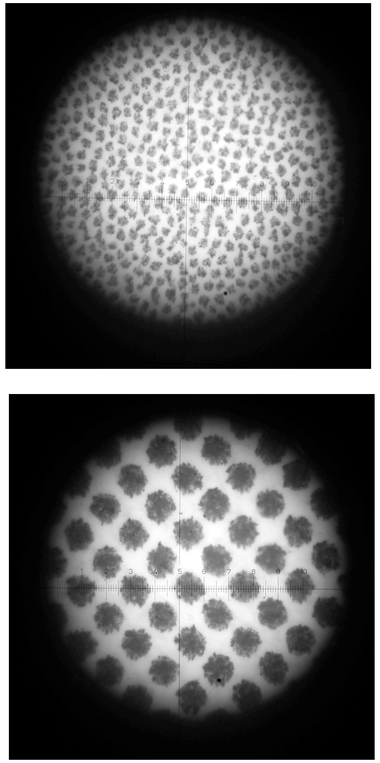


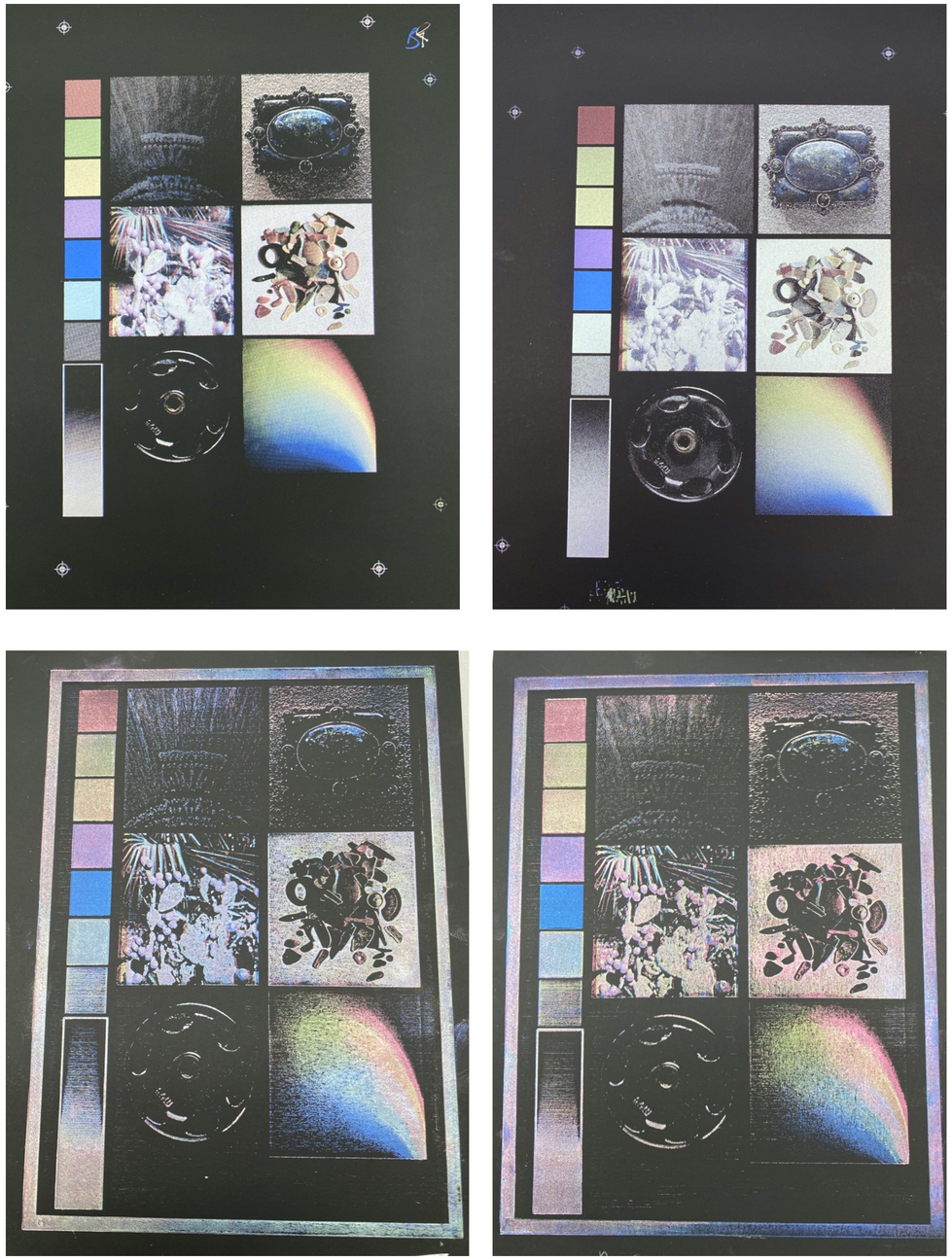
Images by Abigail Trujillo Vazquez, Susanne Klein, Harrie Fuller and Carinna Parraman

PROCESS AND OUTPUT

RGB image
split into RGB
channels







RGB Black means no ink.
White is 100% reg, green and blue

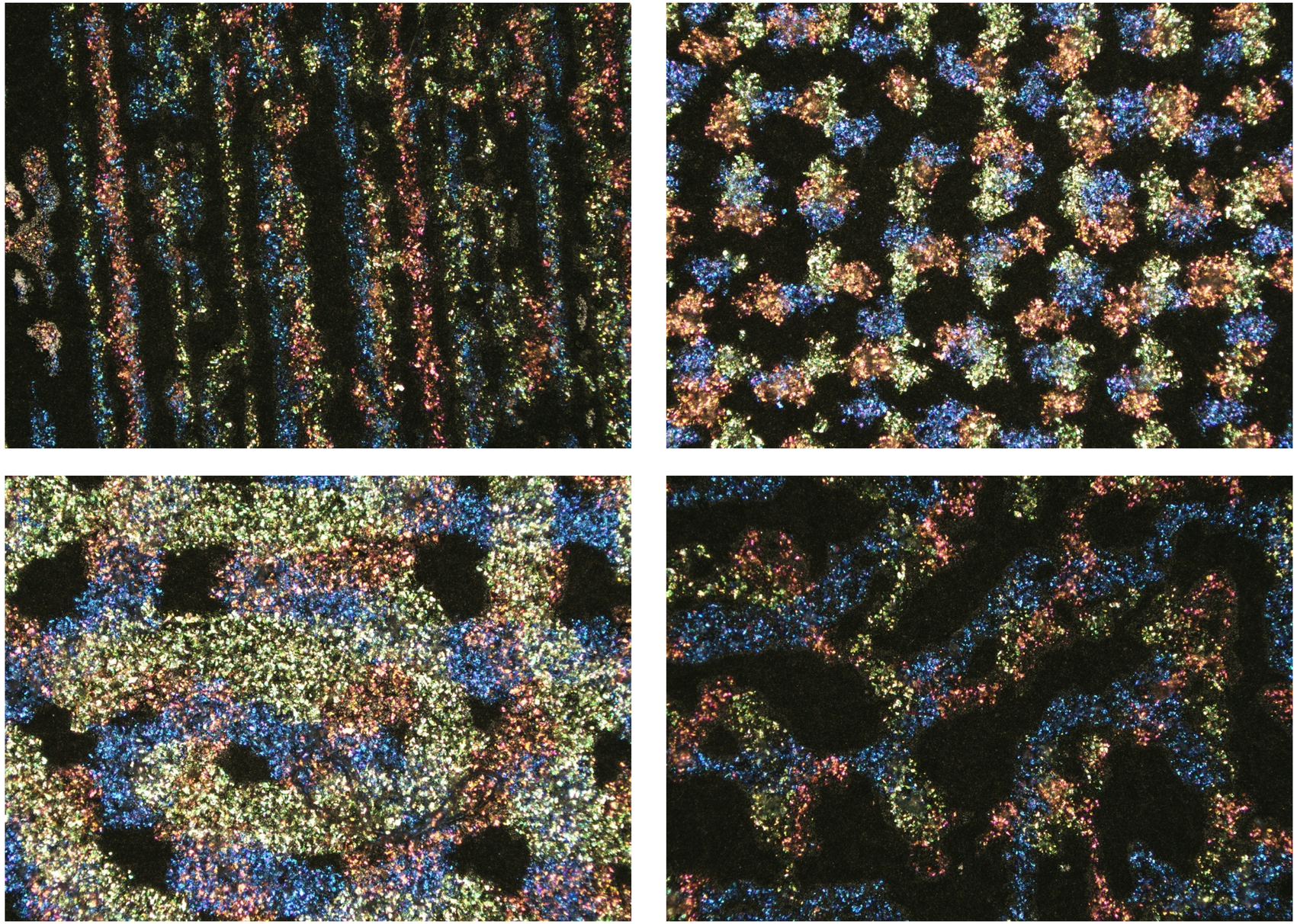
P A P E R

Paper/Supplier	Type	Colour	Measurement		
			L*	A*	B*
John Purcell Paper (www.johnpurcell.net)					
Somerset	Velvet	Black	21.59	0.30	0.35
Velin Arches		Noir	22.18	0.53	-0.93
Magnani	Revere	Black	23.35	0.03	-1.43
G.F Smith (www.gfsmith.com)					
Colorplan	Smooth	Ebony	21.26	0.19	-1.28
Gmund	Urban	Architect Black	22.59	2.27	-2.35
Gmund	Action	Go to Hell Black	23.04	1.96	-1.79
Neenah	Plike	Black	23.58	-0.16	-0.87
Peregrina	Majestic	Anthracite	23.97	-0.31	-3.19
Mohawk	Strathmore Grandee	Black	24.32	0.05	-2.45
Accent	Fresco	Black	28.07	0.23	0.38
Slater Harrison (www.slater-harrison.co.uk)					
Slater Harrison	CenturaPearl	Black	10.78	-015	-1.14
Arboreta Papers (http://arboretapapers.co.uk)					
Arboreta	Sugar Paper	Black	22.53	0.24	-0.61

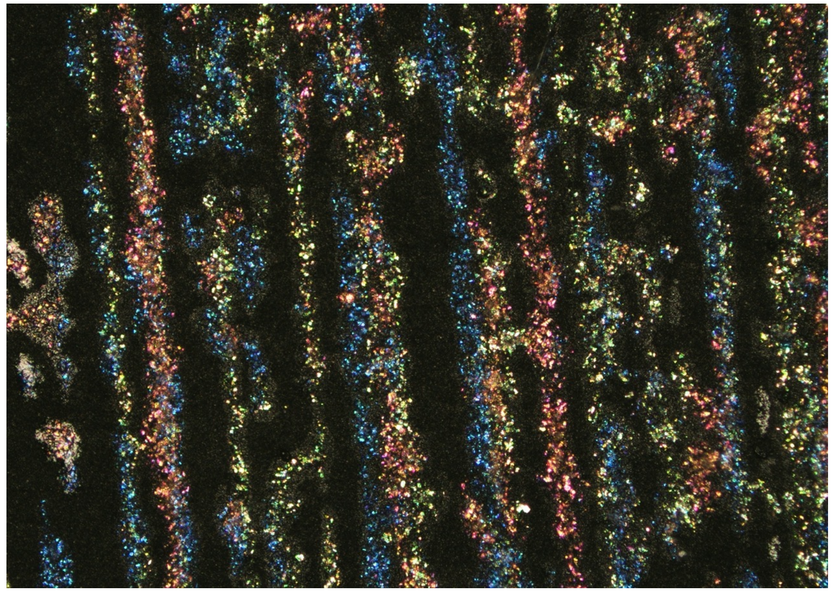
RGB HALFTONING

5X Magnification

- Woodbury Gravure (TL)
- Halftone screenprint (TR)
- Stochastic screenprint (BL)
- Stochastic relief (BR)



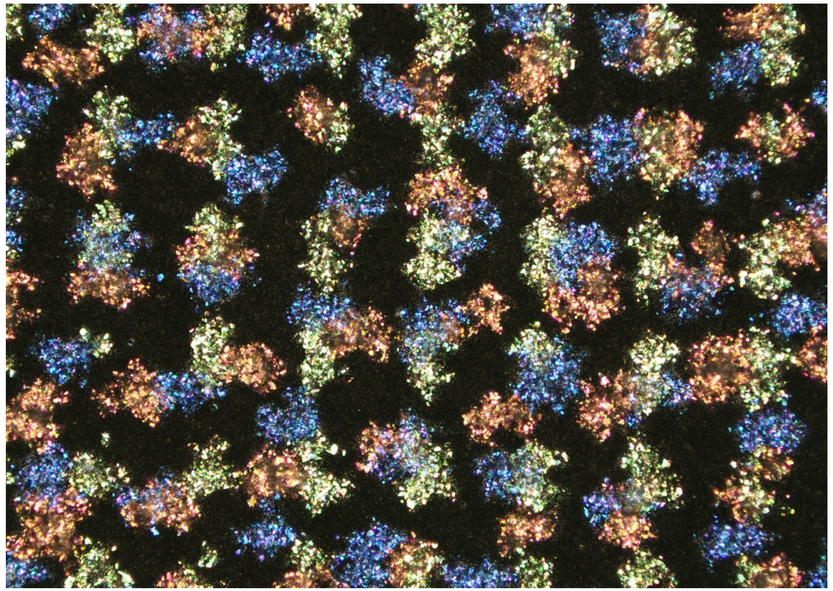
W O O D B U R Y G R A V U R E



Lazer
P 100
V 100 (cut twice) or V50 x 1

600 LPI
600 DPI

HALFTONE SCREENPRINT

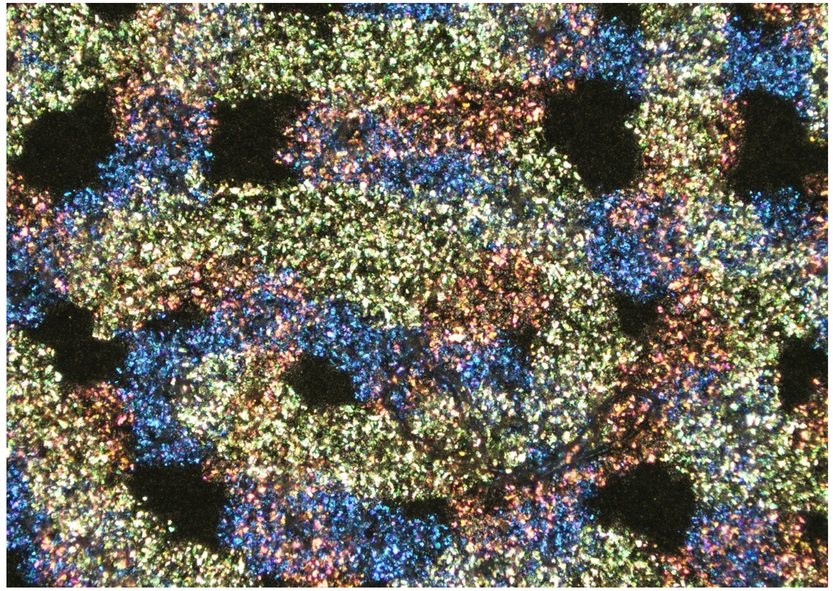


DPI = in 300 out 300
LPI = 75
Angles = R 75, B 15, G 0

S T O C H A S T I C S C R E E N P R I N T

https://stochaster.org/stochaster.html

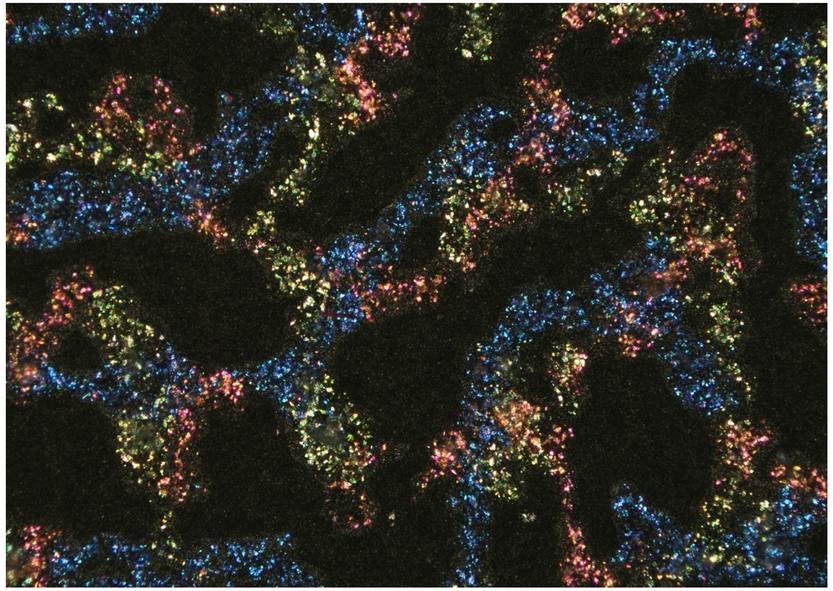
DPI = in 300 out 300
LPI = 50
Angles = R 15, B 45, G 75
Pattern shape = Turing



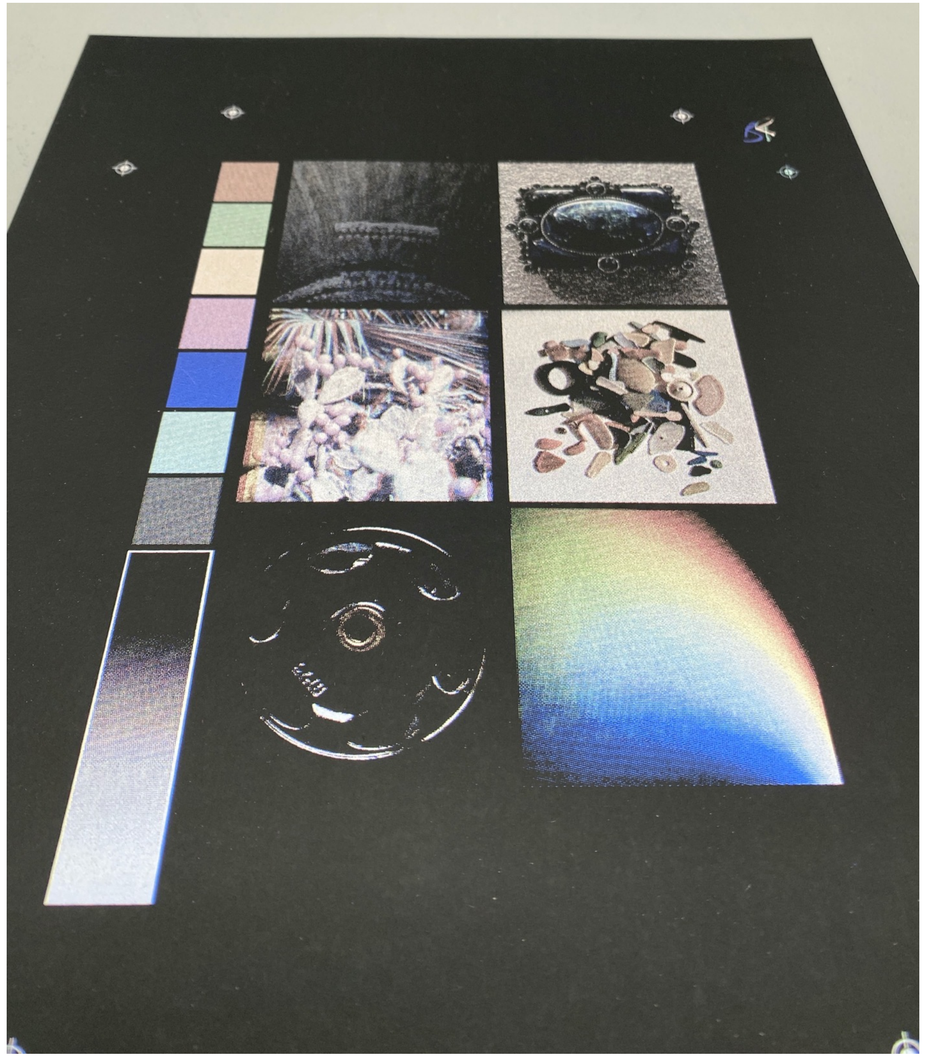
S T O C H A S T I C
R E L I E F

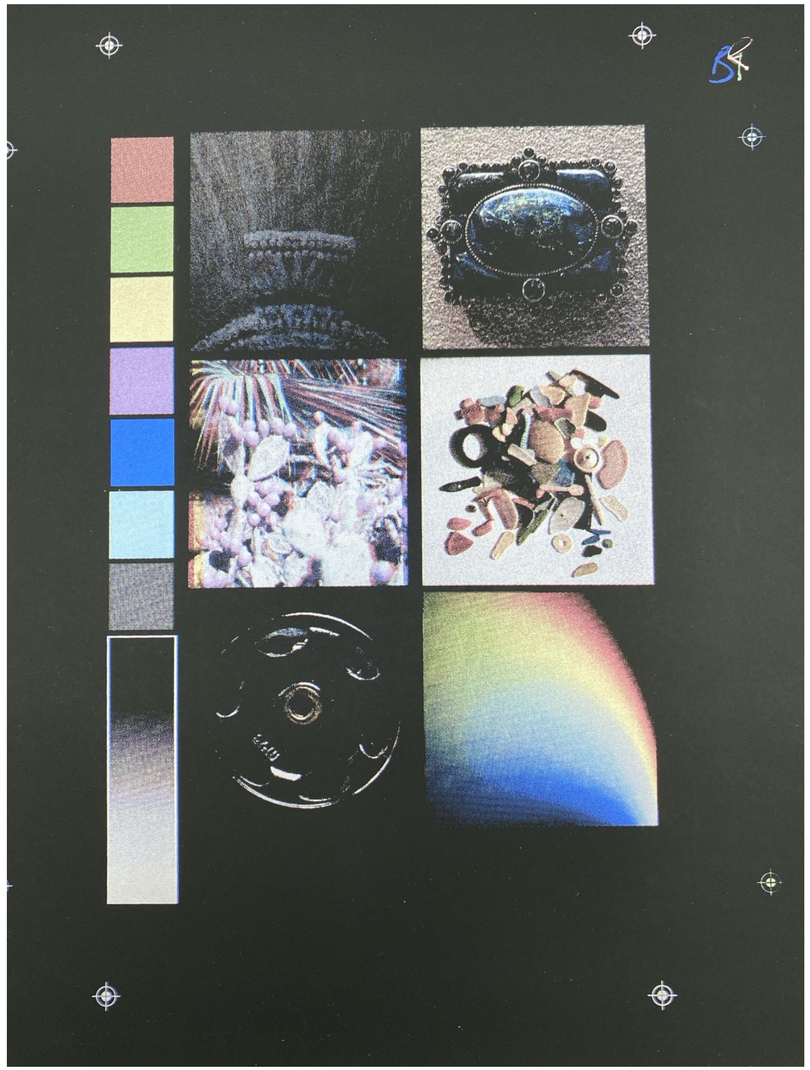
Lazer
P 100
V50

600 LPI
600 DPI

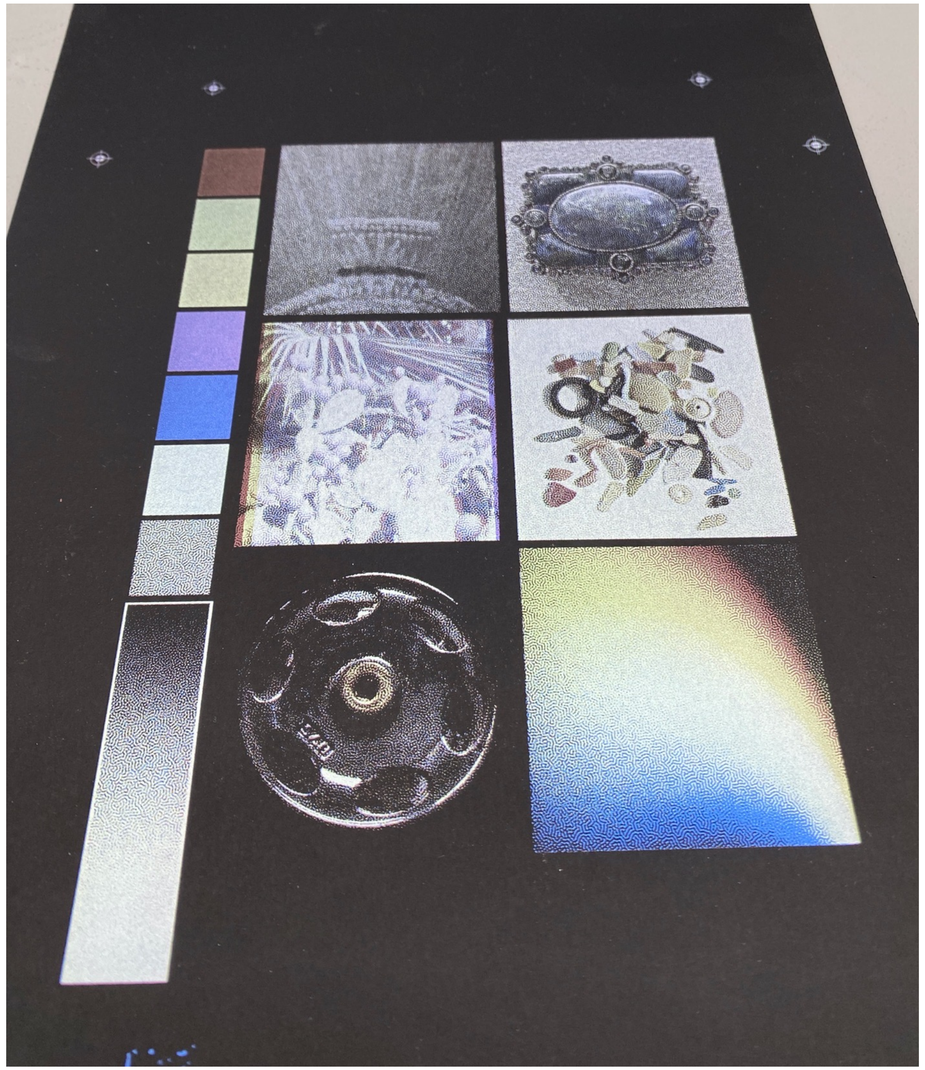


S C R E E N P R I N T

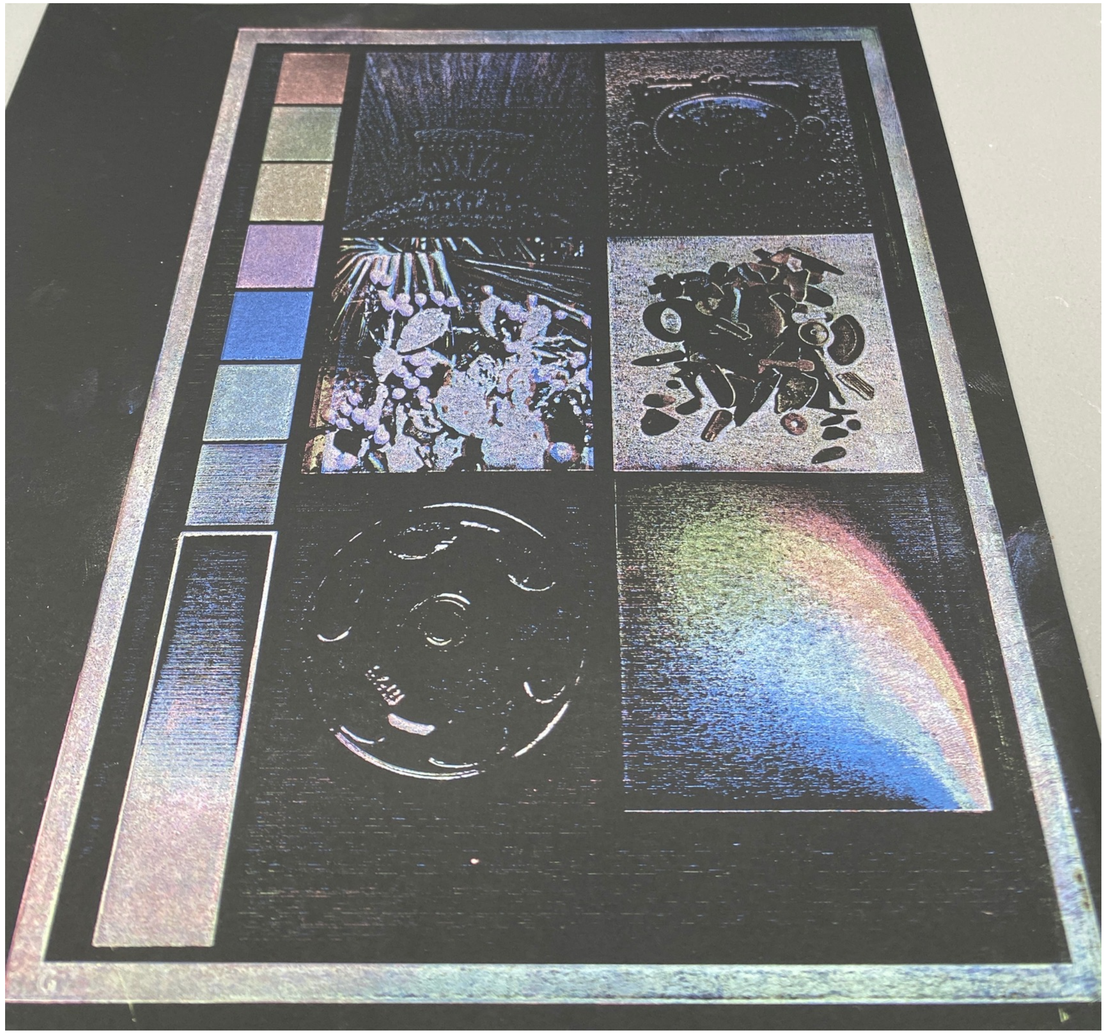


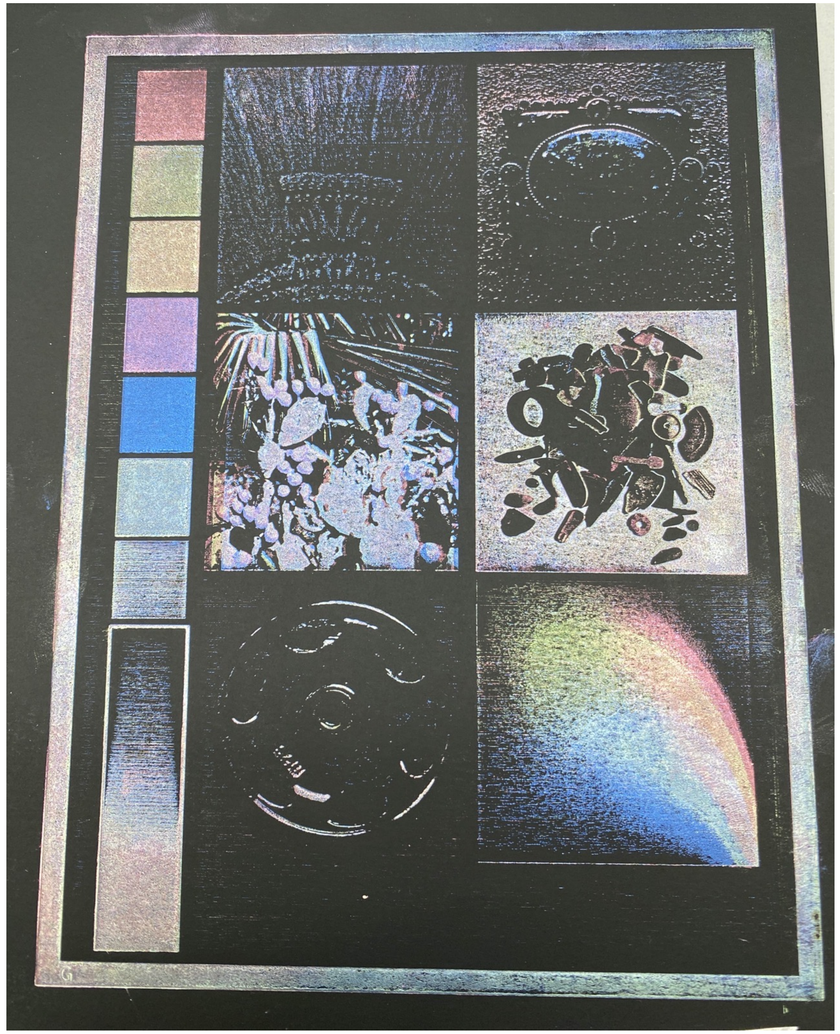


STOCHASTIC SCREENPRINT



WOODBURY GRAVURE





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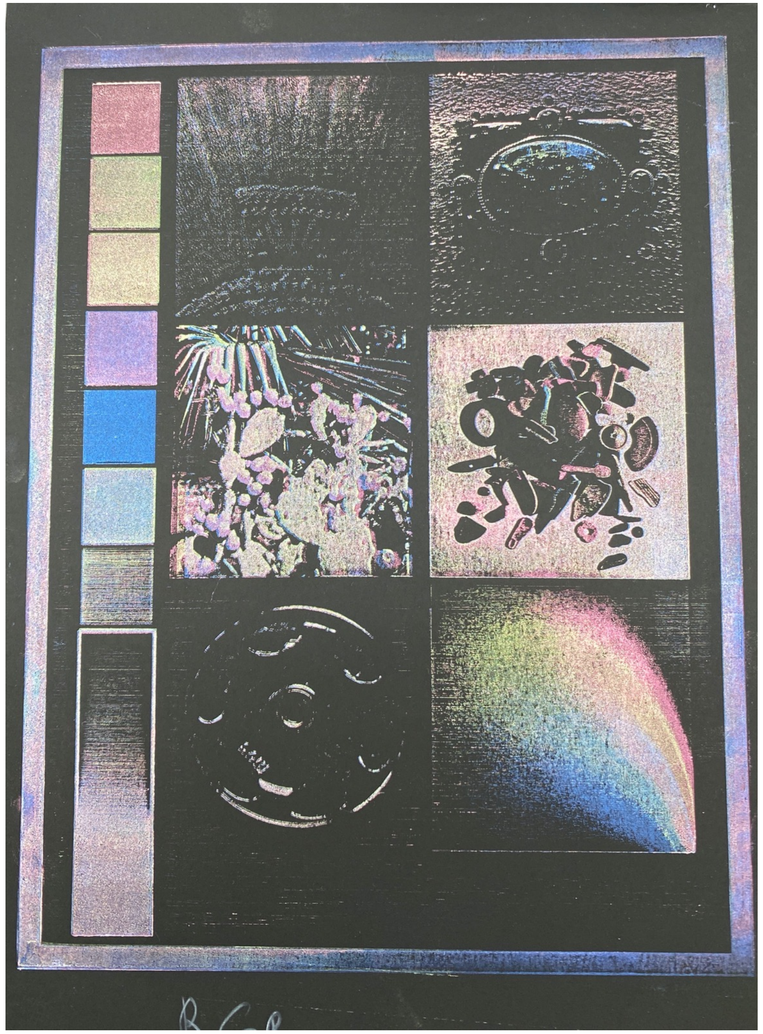
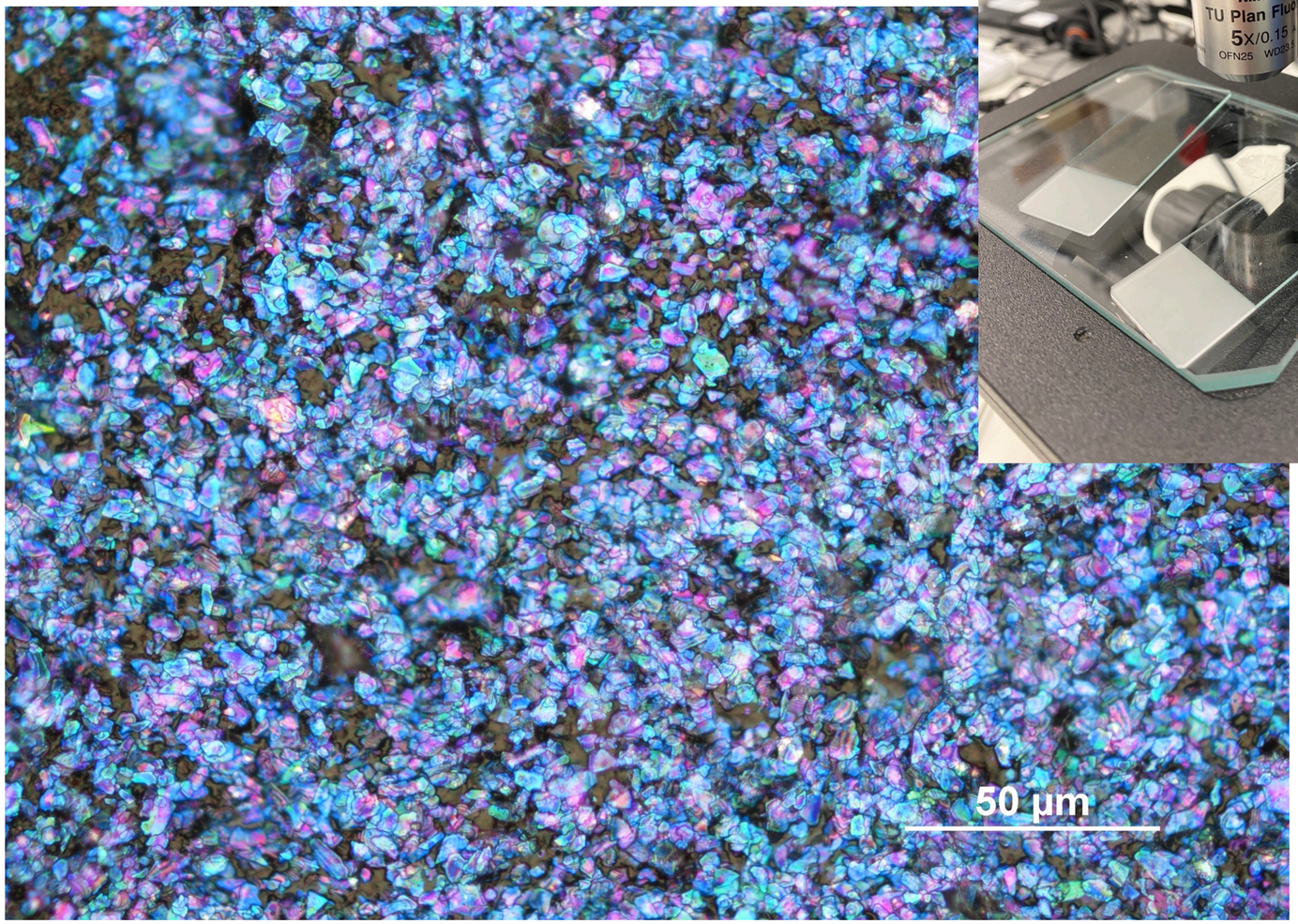
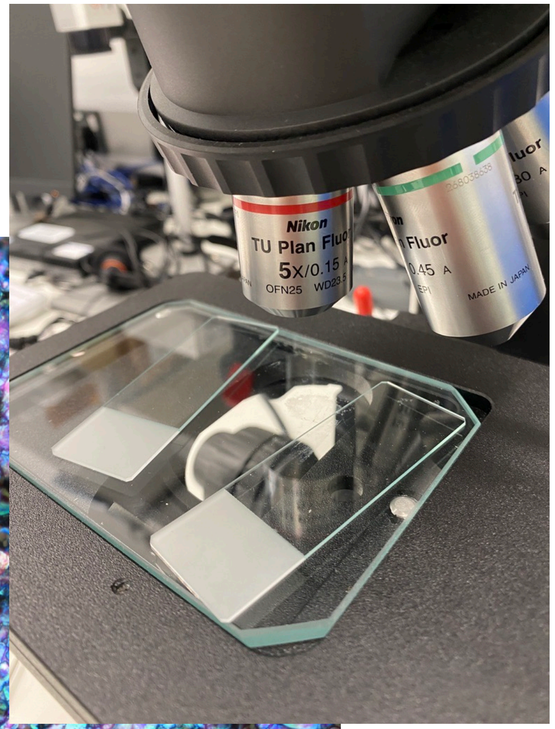


MICRO-PHOTOGRAPHS

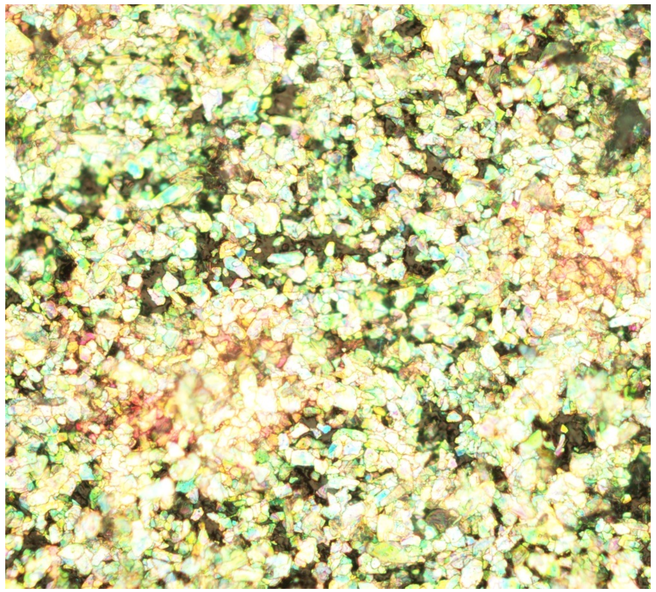
- Nikon Eclipse LV150N
- Digital Sight Camera
- NIS Elements software
- Nikon Optics 20x /0.45 and 5x /0.15





20X Magnification

S C R E E N P R I N T



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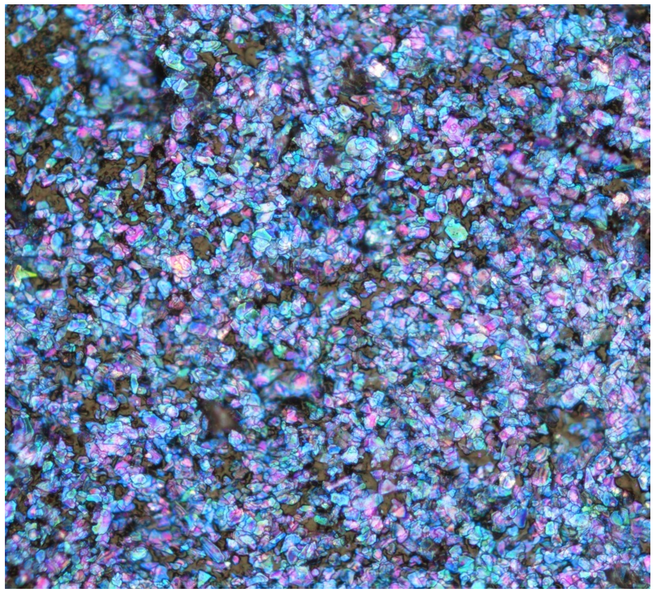

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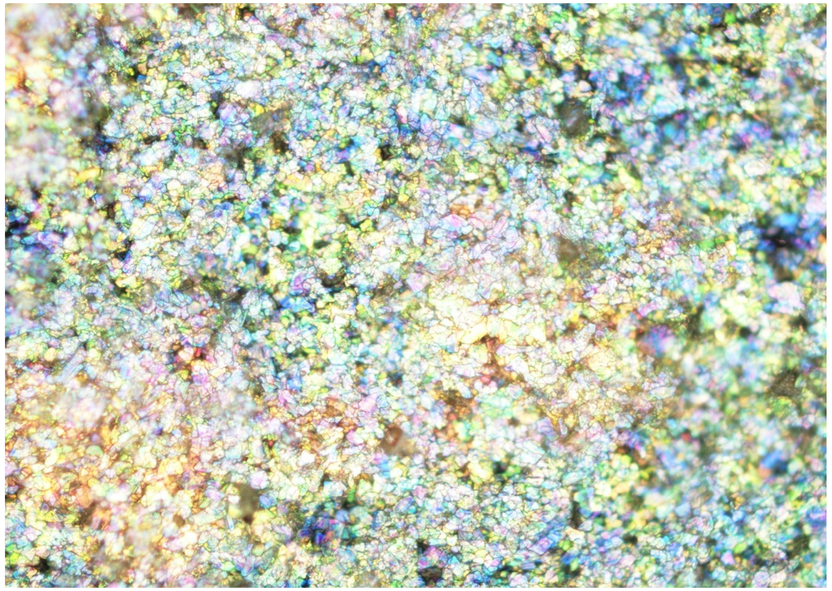
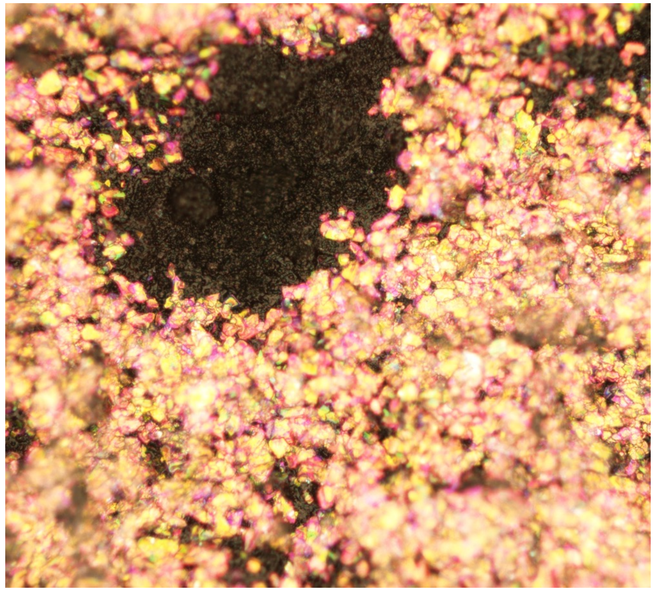


White R+G+B



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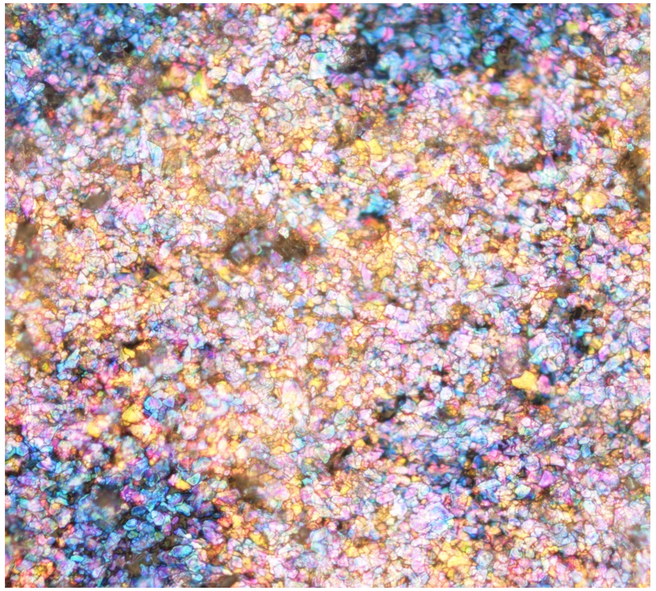
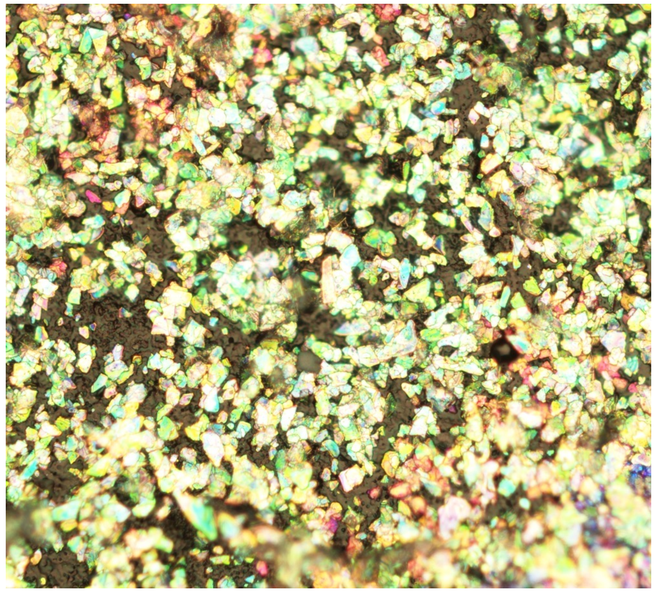


Magenta R+B

STOCHASTIC SCREENPRINT



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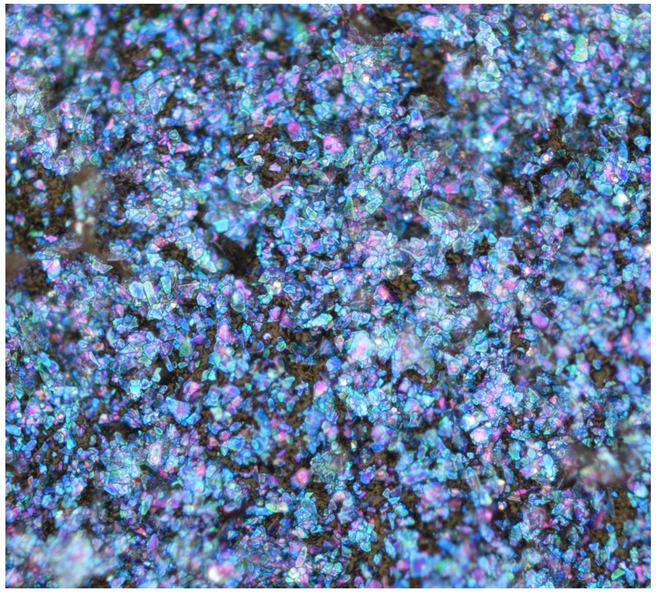

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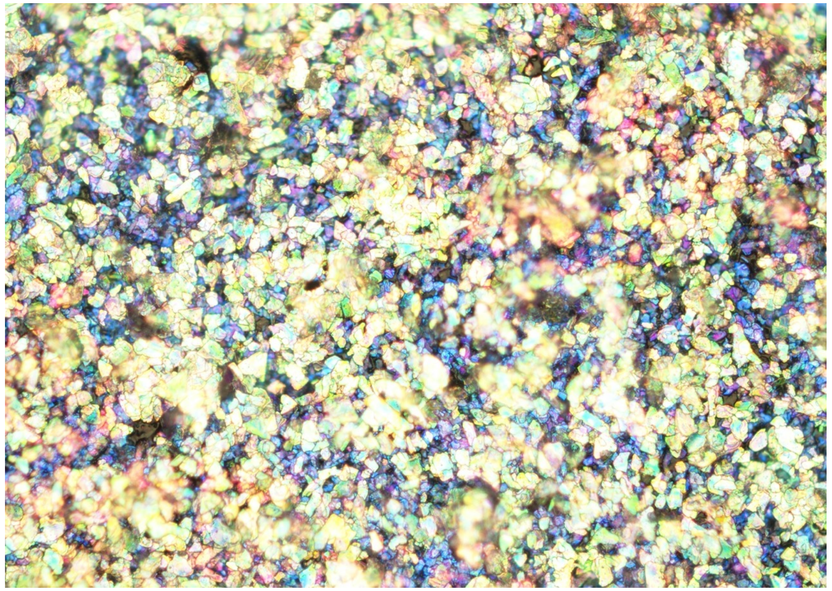

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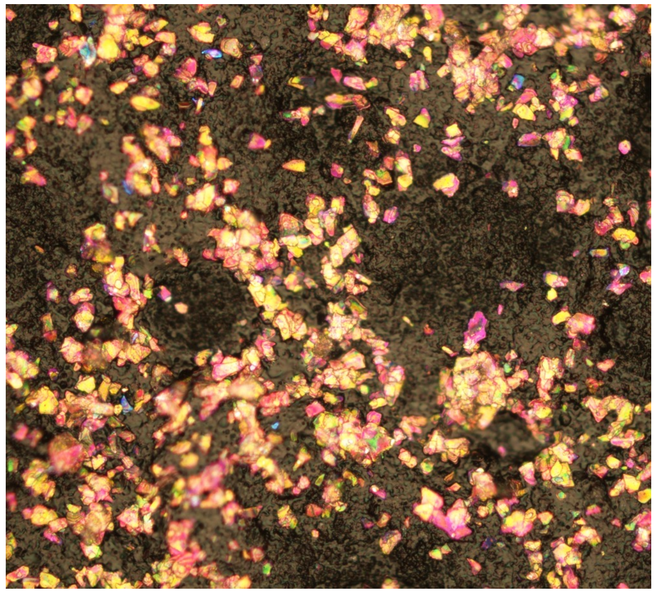

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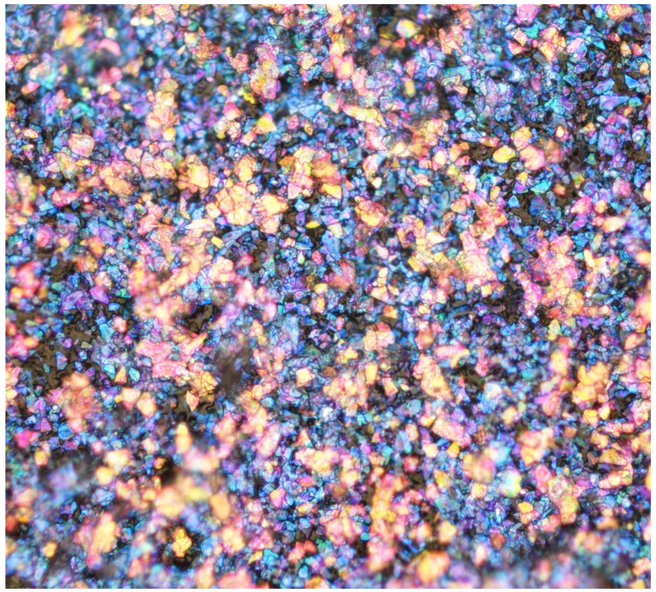
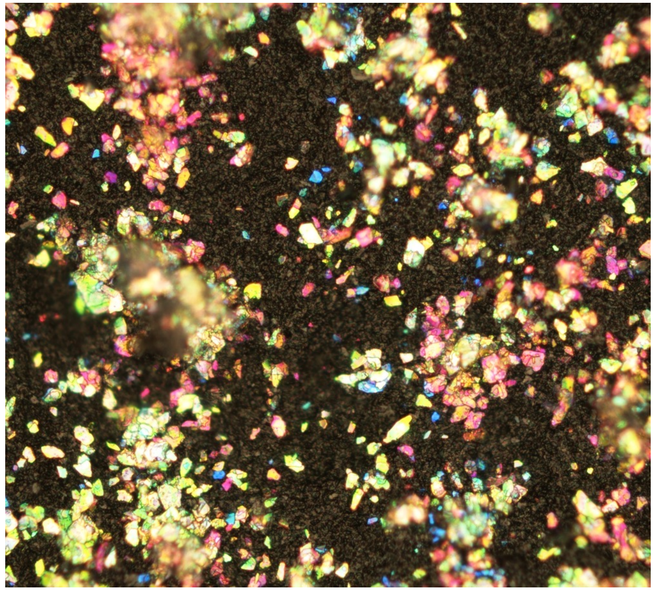


Magenta R+B

WOODBURY GRAVURE



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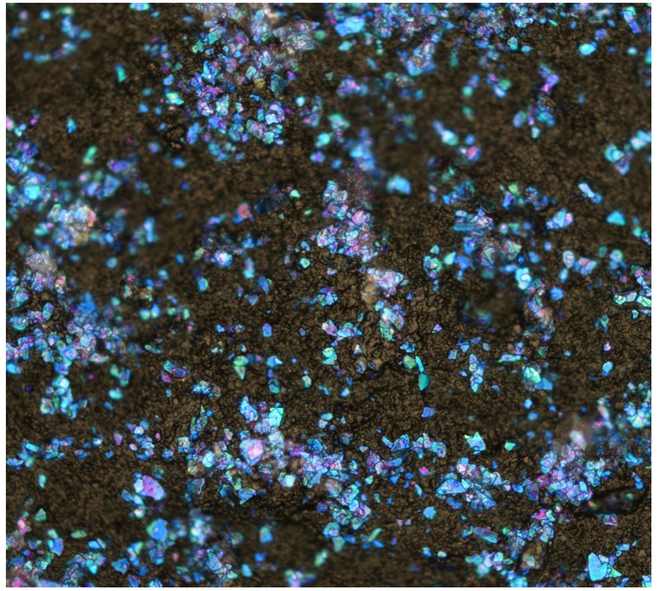

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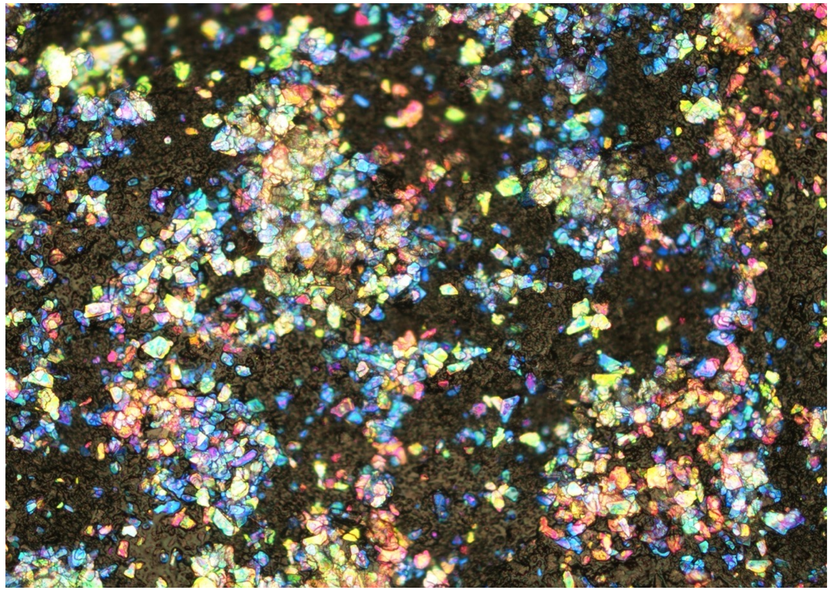

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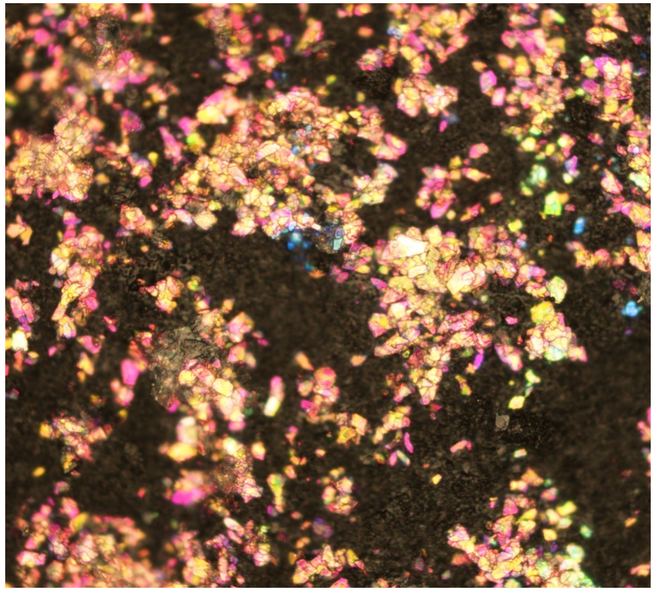

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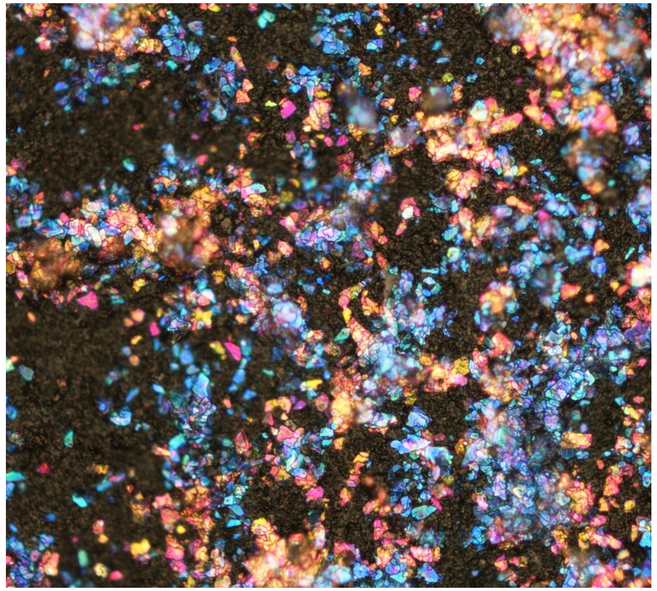
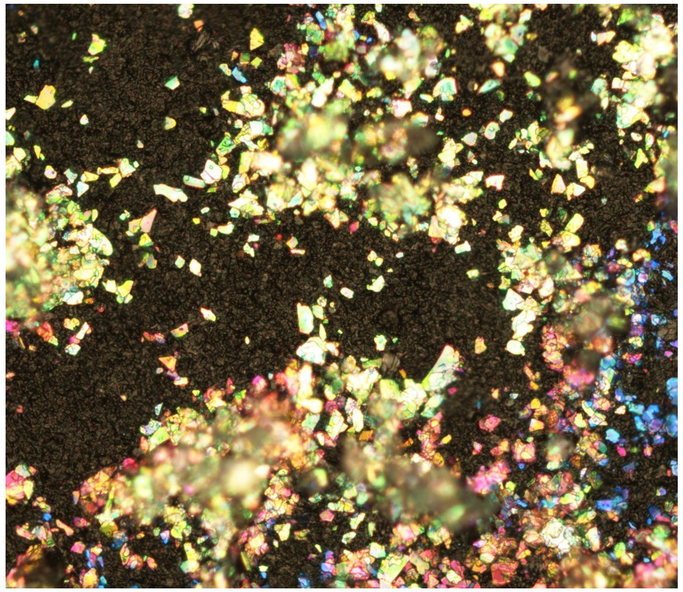


Magenta R+B

STOCHASTIC RELIEF



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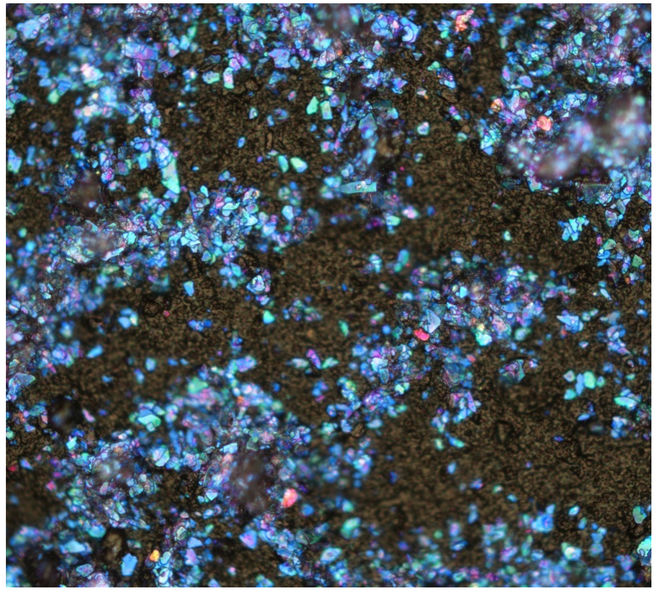

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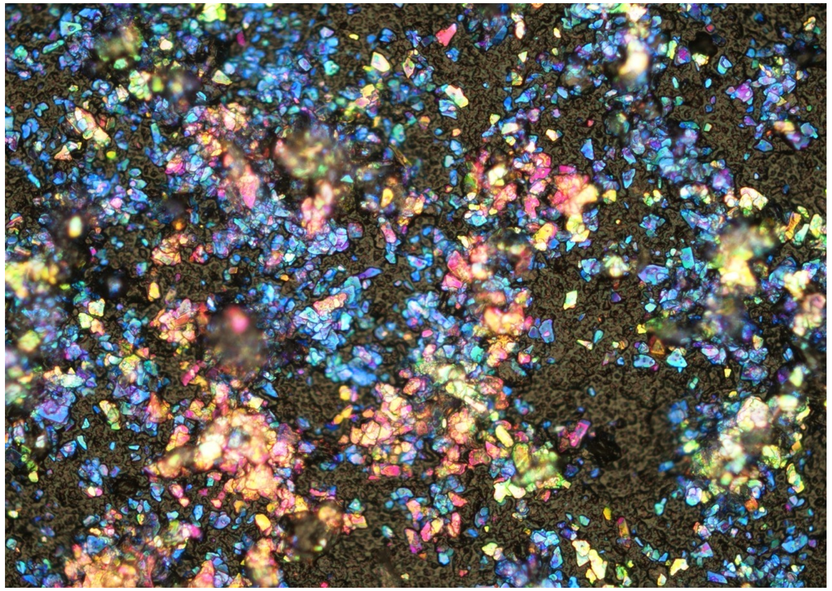

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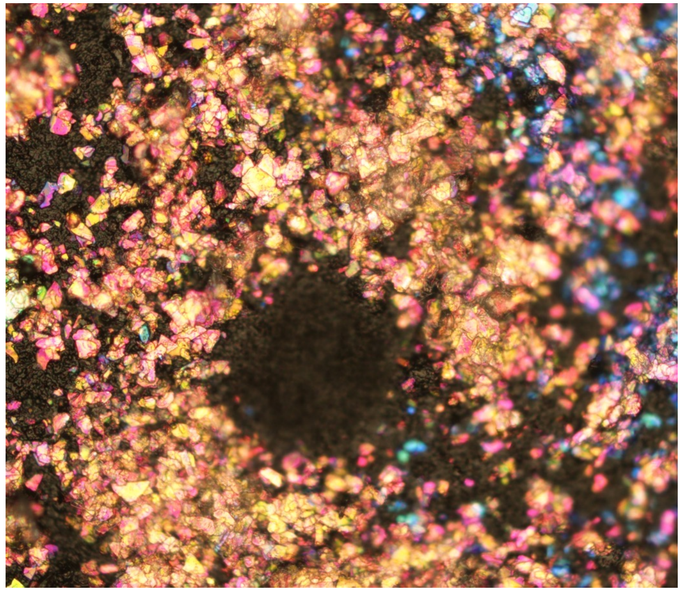

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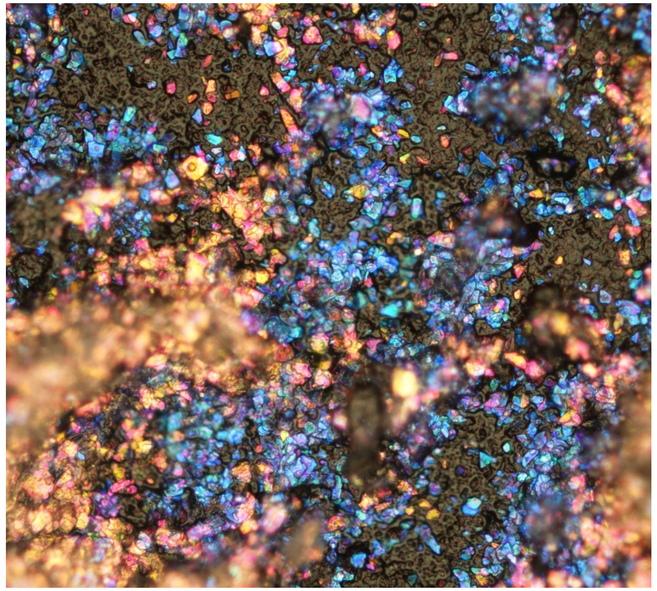
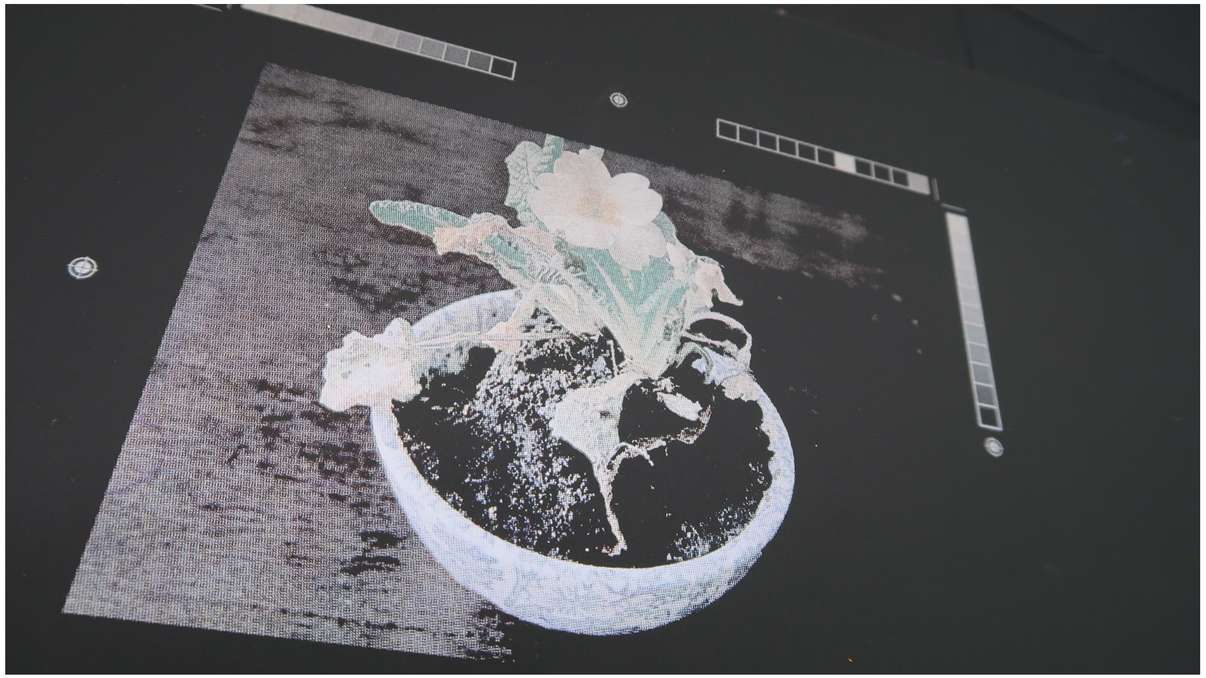
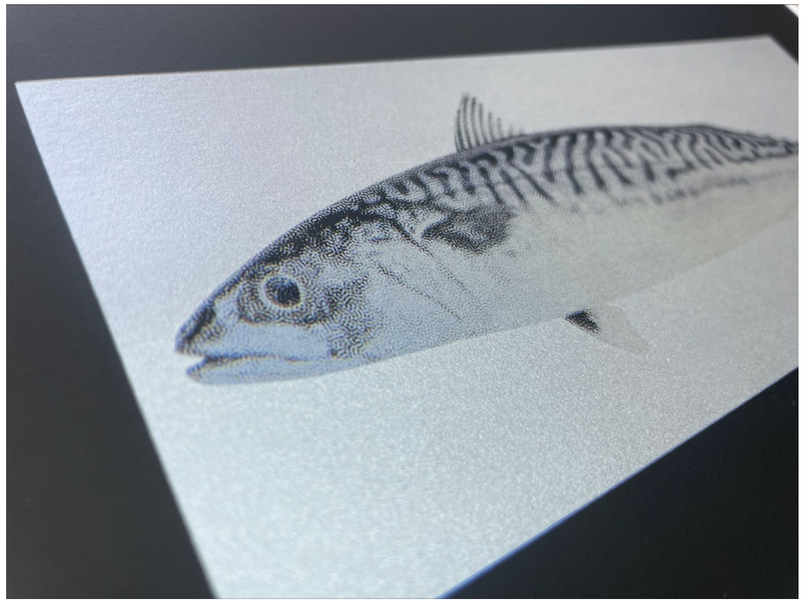
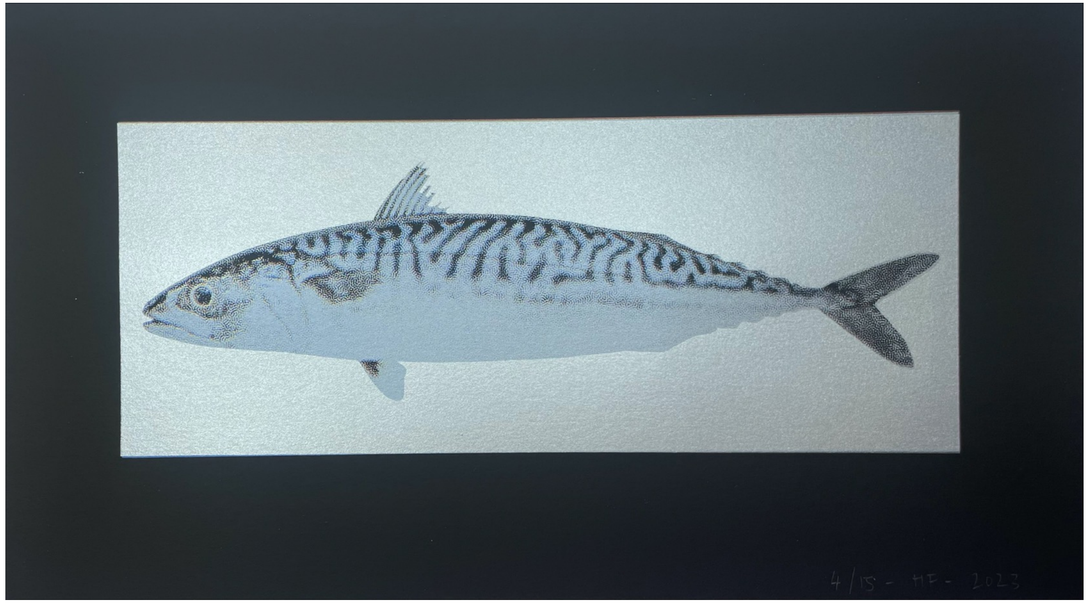


Magenta R+B



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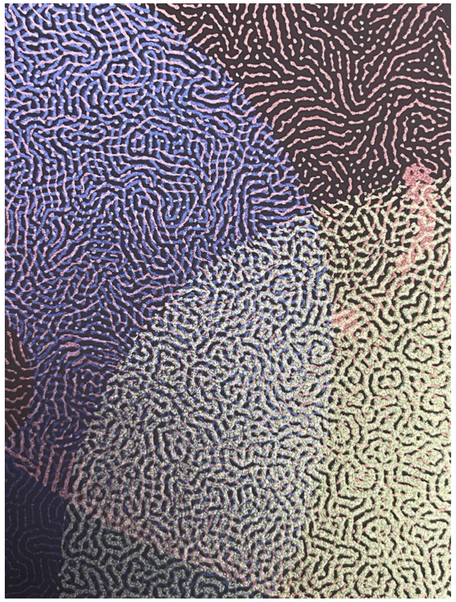

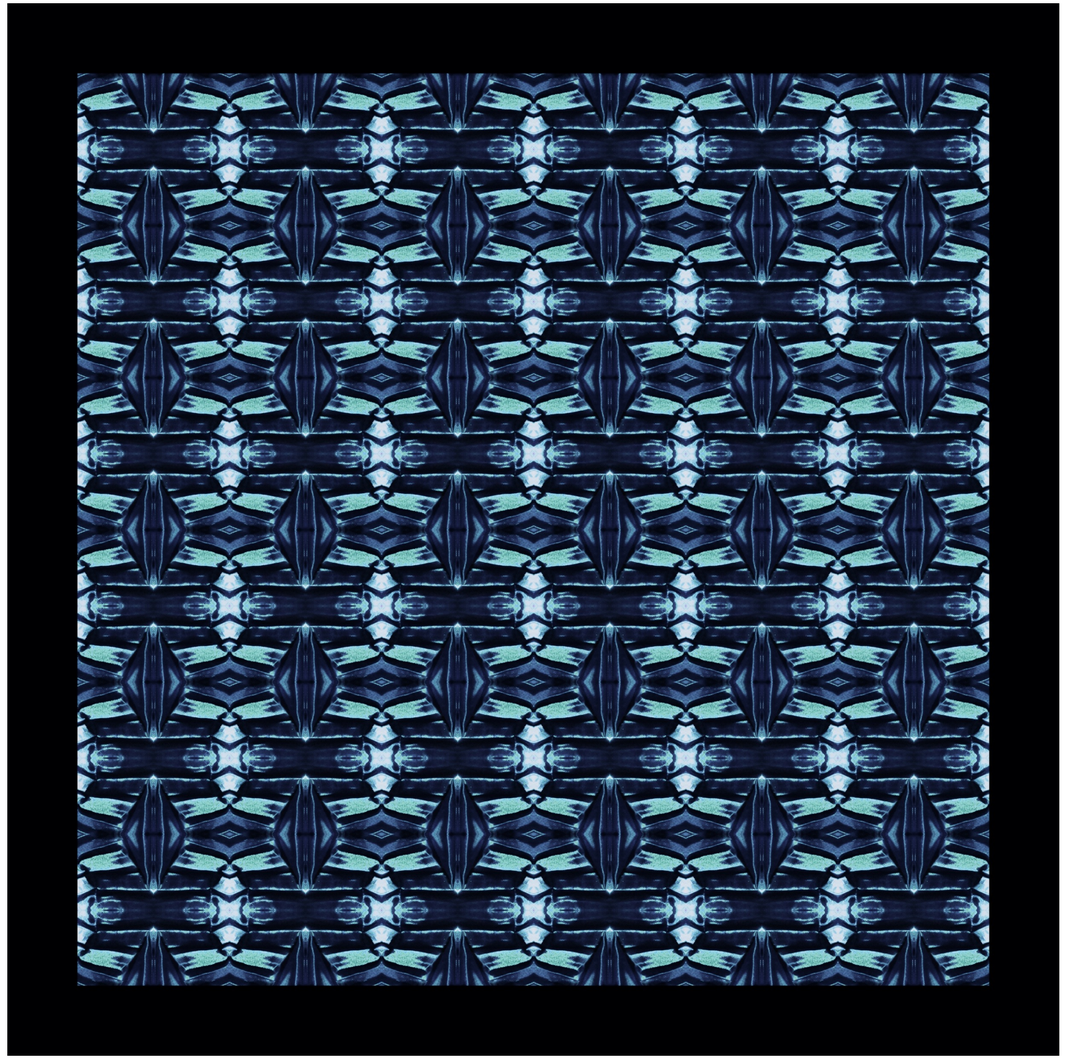

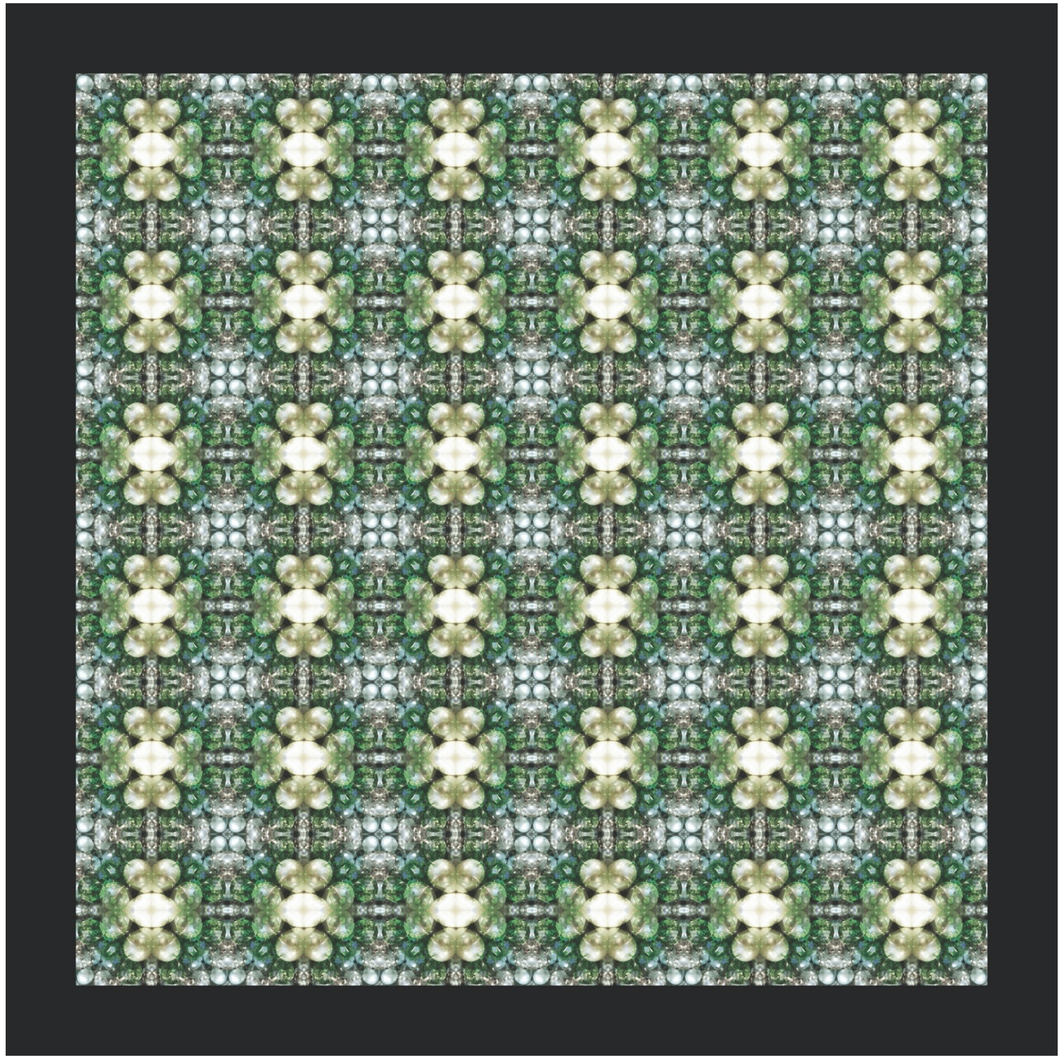

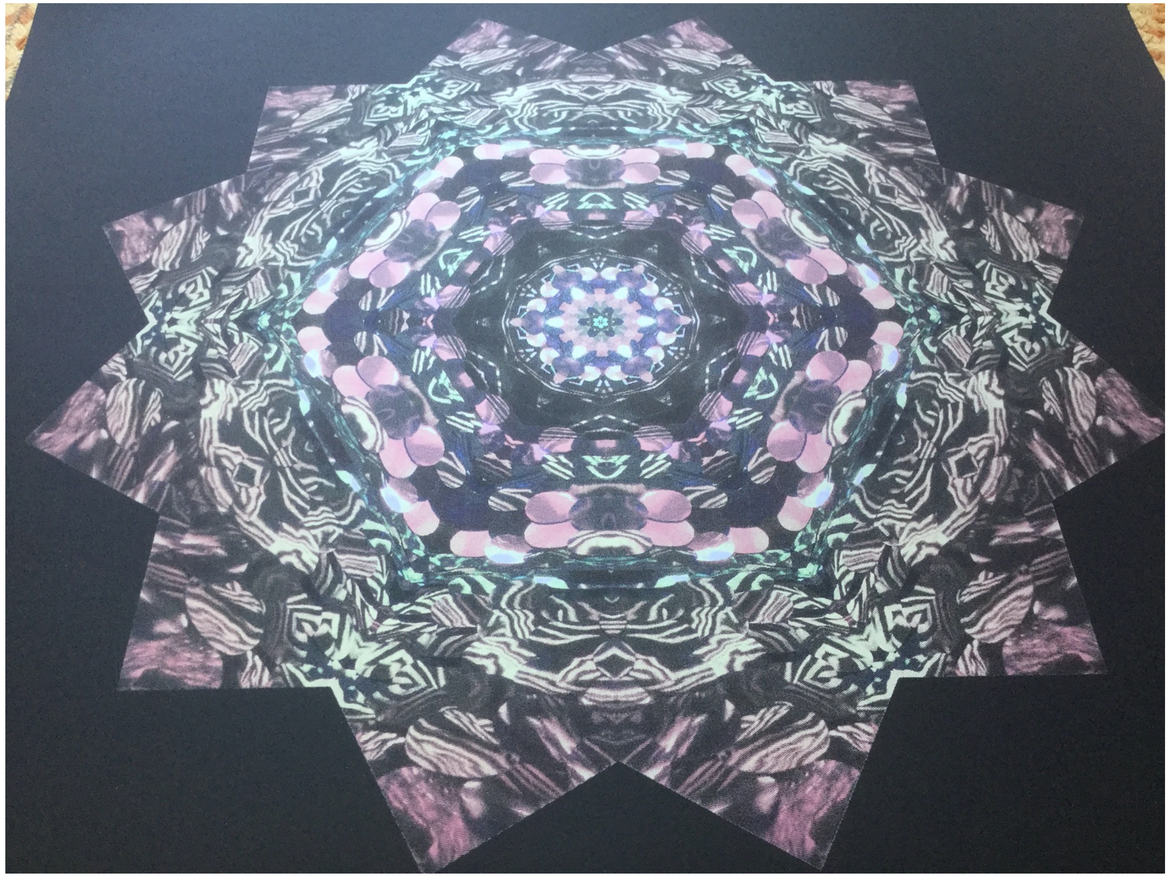

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THANK YOU

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