Holographic material test report

Petr Lobaz, 2012/11/27

the last version can be found at http://holo.zcu.cz/txt/materials_report.pdf

In this test, holographic materials BB640 (Colour Holographic) and Harman HoloFX Red (Harman/Ilford) are tested. The main purpose of the test is to find "the nicest look" for display holography.

The recording setup is the simplest single beam Denisyuk (reflection) scheme. Divergent wave (HeNe laser 18 mW, 632.8 nm) is thrown from a spatial filter (10× objective, 30 µm pinhole) to the object (throw distance approx. 1 m, angle of incidence 45 °). The object is composed of M4 nuts lying on black and white background, the plate touches the object. Typically, four exposures are made on a sigle plate (by covering the rest of the plate with a black cardboard), the lowest in the lower left corner, clockwise to the highest in the lower right corner.

The hologram is then processed. The developer and bleach recipes used are:

Pyrogallol (Pyro) developer
(recommended by Colour Holographic for reflection)
A: 60 g sodium carbonate, 1 litre distilled water
B: 10 g pyrogallol, 1 litre distilled water

AAP developer
(recommended by Colour Holographic for transmission)
A: 40 g ascorbic acid, 2 g phenidone, 1 litre distilled water
B: 40 g sodium carbonate, 14 g sodium hydroxide, 1 litre distilled water

JD-4 developer
A: 4 g metol, 25 g ascorbic acid, 1 litre distilled water
B: 70 g sodium carbonate, 15 g sodium hydroxide, 1 litre distilled water

SM-6 developer
A: 36 g ascorbic acid, 12 g phenidone, 1 litre distilled water
B: 24 g sodium hydroxide, 56.8 g sodium phosphate (dibasic), 1 litre distilled water

Fe-EDTA bleach
(recommended by both Colour Holographic and Harman for both reflection/transmission)
30 g EDTA(2Na), 30 g Fe-III sulfate, 30 g potassium bromide, 30 g sodium hydrogen sulphate, 1 litre distilled water

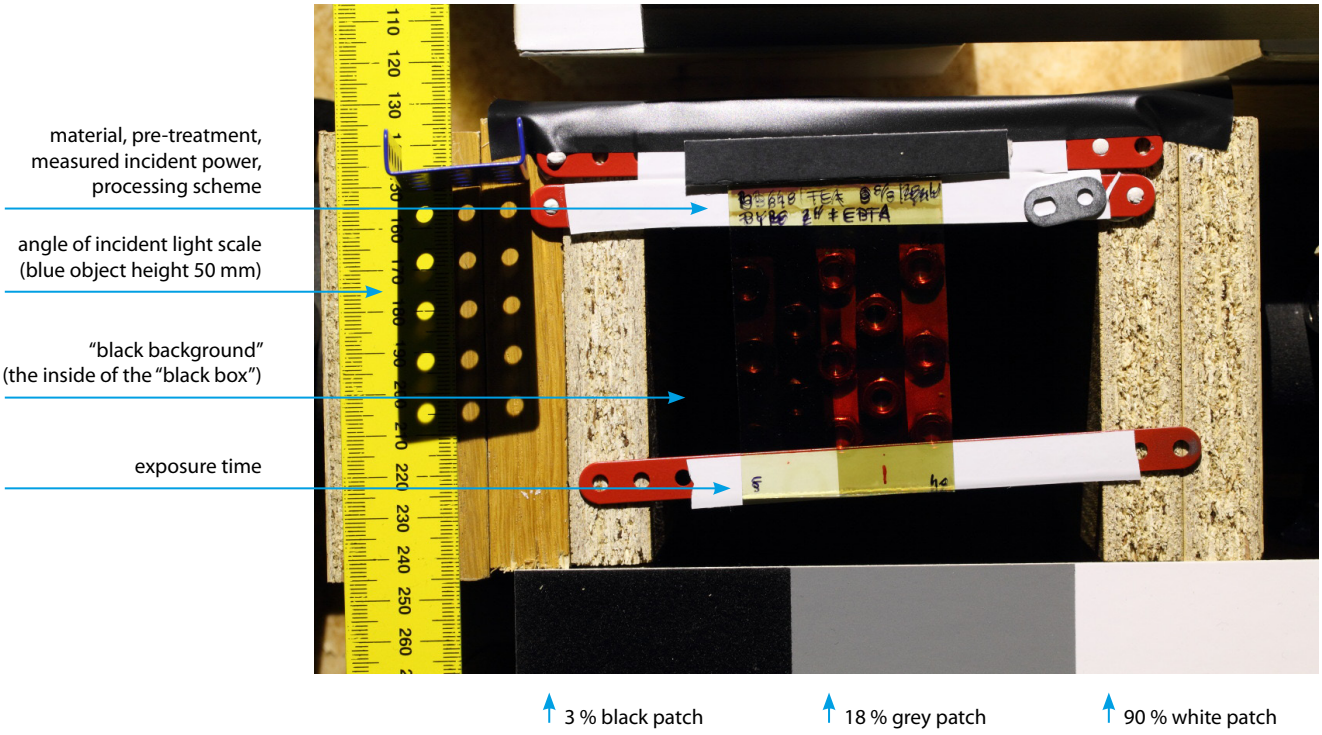
JD-2 bleach
5 g potassium dichromate, 80 g sodium bisulfate, 1 litre distilled water

JD-4 bleach
35 g copper sulfate pentahydrate, 100 g potassium bromide, 5 g sodium hydrogen sulfate, 1 litre distilled water

PBU-Amidol bleach
10 g potassium persulfate, 10 g citric acid, 20 g potassium bromide, 1 g cupric bromide, 1 g amidol, 1 litre distilled water

The holograms are then photographed; the holograms are at least one week old. The reconstruction light is a spot white LED reflector, approximate distance to the hologram 1 m, variable angle of incidence. The background behind the hologram is the interior of the "black box", i.e. it reflects almost no light. The camera (Canon 550D, EF-S 60mm f/2.8 Macro USM) is placed above the hologram, normal incidence, manual focus. The photographs are in RAW format; in post-processing, exposure and white balance is corrected so that 18 % neutral grey card matches RGB 128,128,128. The white strips you can see above and below the hologram are made of white tape, reflectance > 90 %.

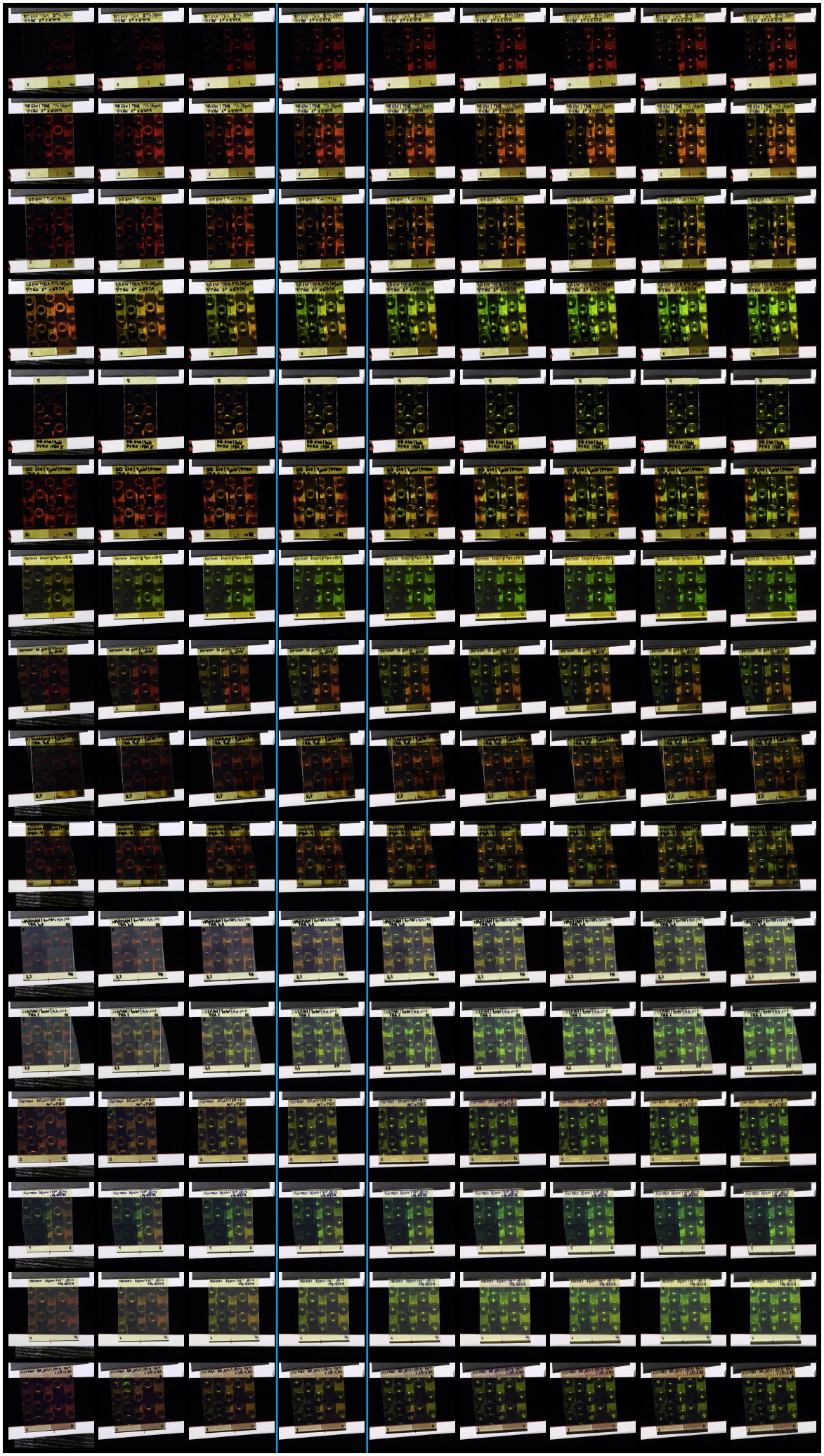
Just for reference a single full image is reproduced here; the rest of this report contains just the central area.



First, an overview is given with all photographs at once. This page can be used for comparision, use a "magnifying glass" tool in a PDF reader. Each column stands for a particular angle of incidence of the reconstruction light (angle with normal), every column for a different processing scheme. The meaning of the description is as follows in the example:

001 (2)	number of the test (internal number, do not care)
BB640, water	recording material, optional pre-treatment
Pyro (2') + Fe-EDTA	developer (time) + bleach
100 – 200 – 400 – 800 µJ	incident energy (100 in the lower left, 800 in the lower right corner) measured in µJ/cm^2

The next pages show the detailed results. The descriptions given should be self-explanatory.



001 (2)
BB640, water
Pyro (2') + Fe-EDTA
100 – 200 – 400 – 800 µJ

002 (5)
BB640, TEA 1 %
Pyro (2') + Fe-EDTA
100 – 200 – 300 – 400 µJ

003 (1)
BB640, TEA 2.5 %
Pyro (1') + Fe-EDTA
35 – 70 – 140 – 280 µJ

004 (6)
BB640, TEA 5 %
Pyro (2') + Fe-EDTA
100 – 200 – 400 – 800 µJ

005 (3)
BB640, TEA 5 %
Pyro (1') + Fe-EDTA
35 – 70 – 140 µJ

006 (4)
BB640, TEA 5 %
Pyro (1') + Fe-EDTA
140 – 200 – 280 – 400 µJ

007 (8)
Harman Red
Pyro (2') + JD-2
40 – 80 – 160 – 320 µJ

008 (7)
Harman Red
Pyro (2') + Fe-EDTA
40 – 80 – 160 – 320 µJ

009 (9)
Harman Red, TEA 2.5 %
Pyro (1') + Fe-EDTA
18 – 35 – 70 – 140 µJ

010 (2)
Harman Red, TEA 5 %
Pyro (1') + Fe-EDTA
18 – 35 – 70 – 140 µJ

011 (6)
Harman Red, TEA 2.5 %
AAP (1') + Fe-EDTA
18 – 35 – 70 – 140 µJ

012 (5)
Harman Red, TEA 5 %
AAP (1') + Fe-EDTA
18 – 35 – 70 – 140 µJ

013 (3)
Harman Red
SM-6(70") + PBU-Amidol
40 – 80 – 160 – 320 µJ

014 (4)
Harman Red
JD-4 (45") + Fe-EDTA
20 – 40 – 80 – 160 µJ

015 (1)
Harman Red
JD-4 (45") + Fe-EDTA
80 – 160 – 320 – 640 µJ

016 (10)
Harman Red
JD-4 (45") + JD-4
40 – 80 – 160 – 320 µJ

001 (2)

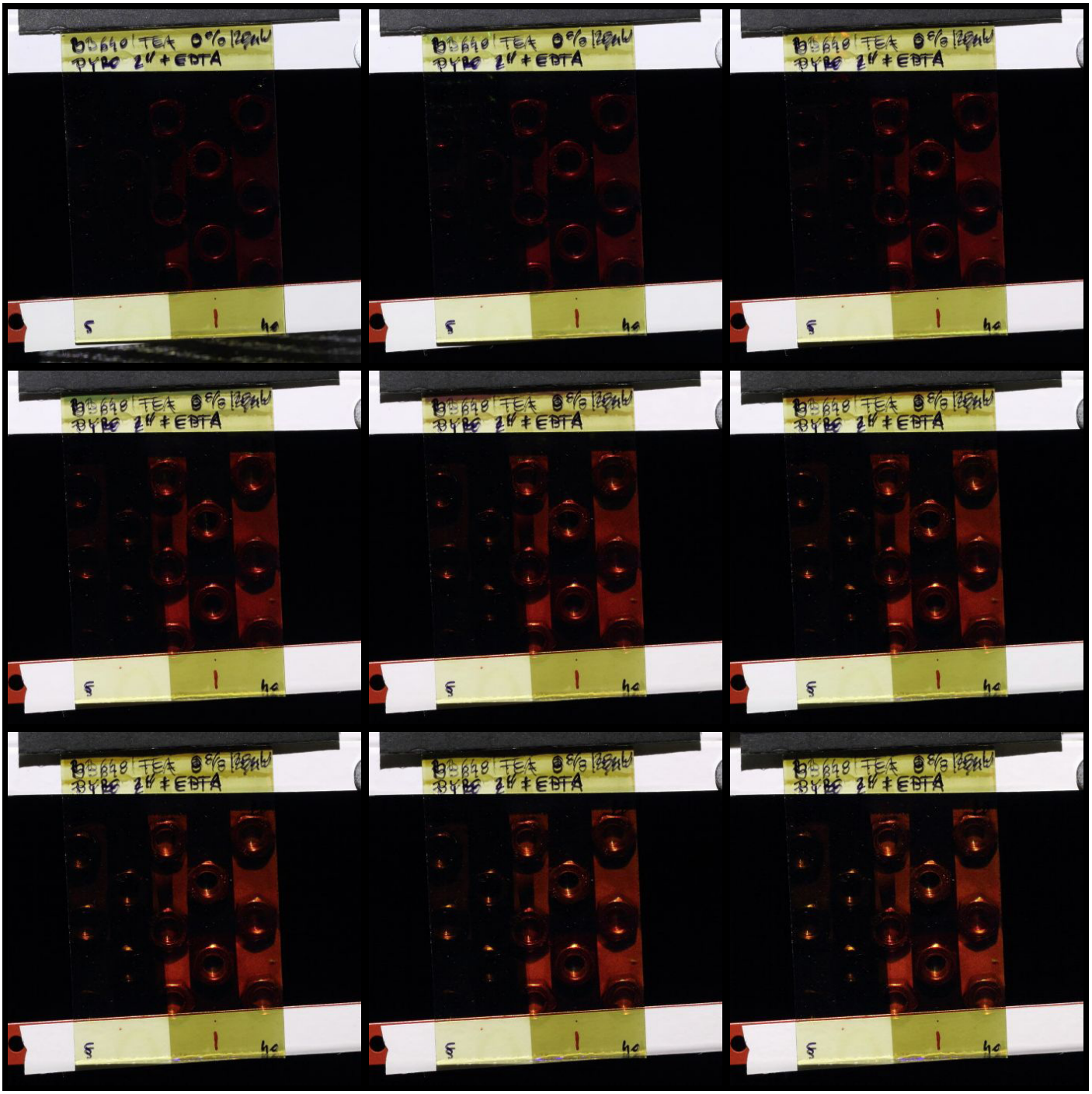
material	BB640 (Colour Holographic)
pre-treatment	distilled water soak (1')
developer	Pyrogallol (2')
bleach	Fe-EDTA
post-treatment	–
power	20 µW/cm^2
exposure	5 – 10 – 20 – 40 s
energy	100 – 200 – 400 – 800 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



002 (5)

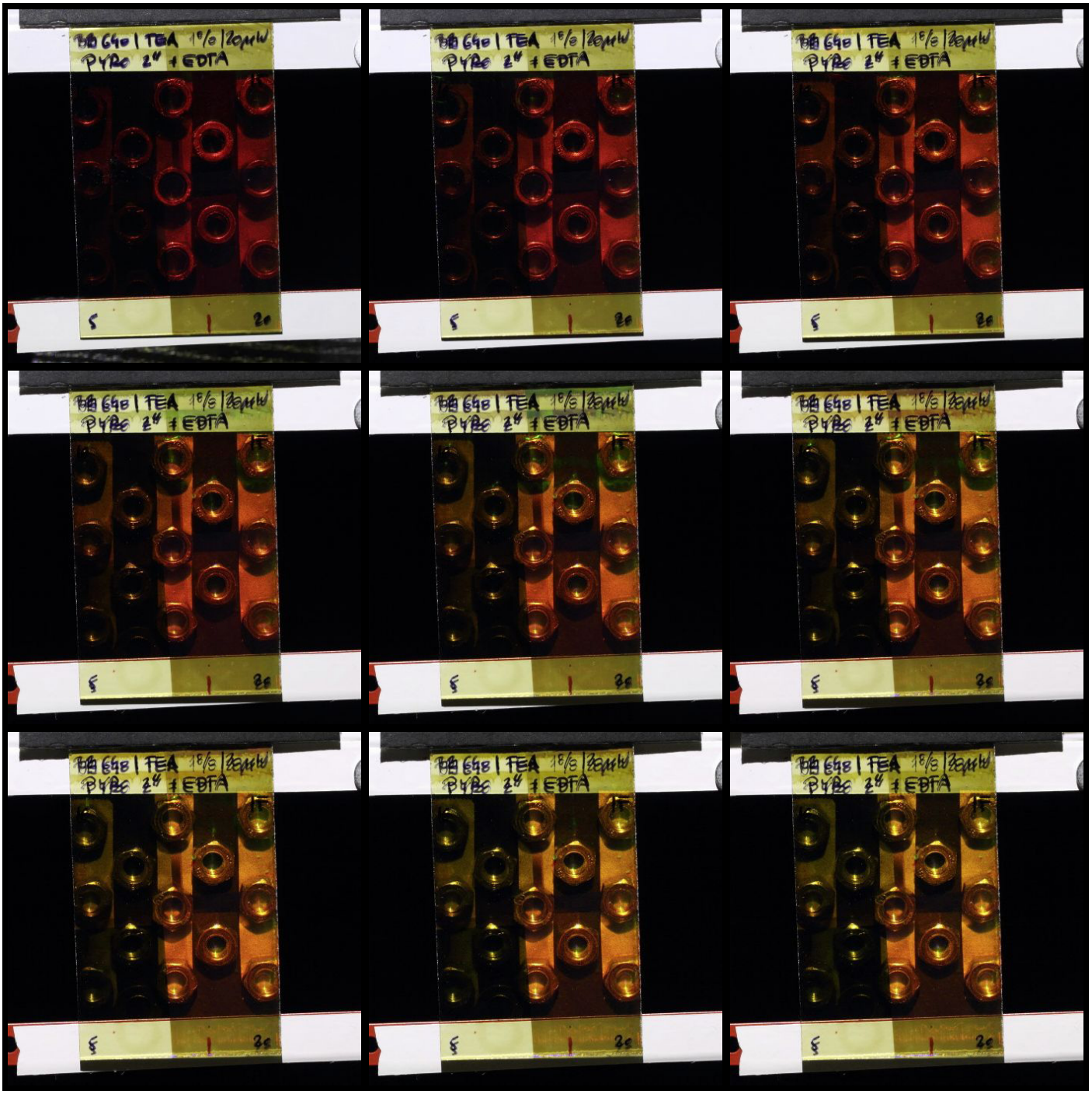
material	BB640 (Colour Holographic)
pre-treatment	TEA 1 %
developer	Pyrogallol (2')
bleach	Fe-EDTA
post-treatment	–
power	20 µW/cm^2
exposure	5 – 10 – 20 – 40 s
energy	100 – 200 – 300 – 400 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



003 (1)

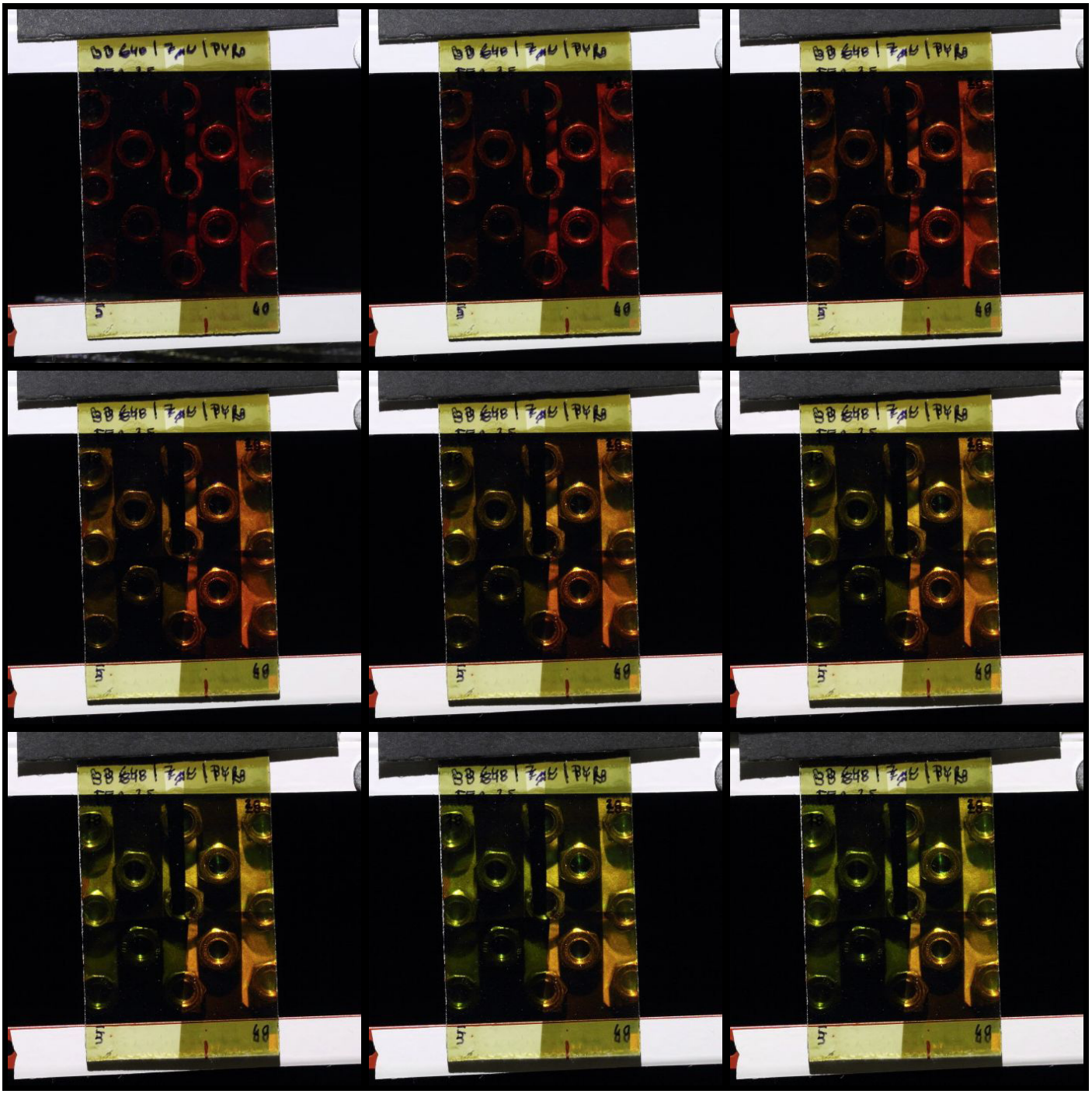
material	BB640 (Colour Holographic)
pre-treatment	TEA 2.5 %
developer	Pyrogallol (1')
bleach	Fe-EDTA
post-treatment	–
power	7 µW/cm^2
exposure	5 – 10 – 20 – 40 s
energy	35 – 70 – 140 – 280 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



004 (6)

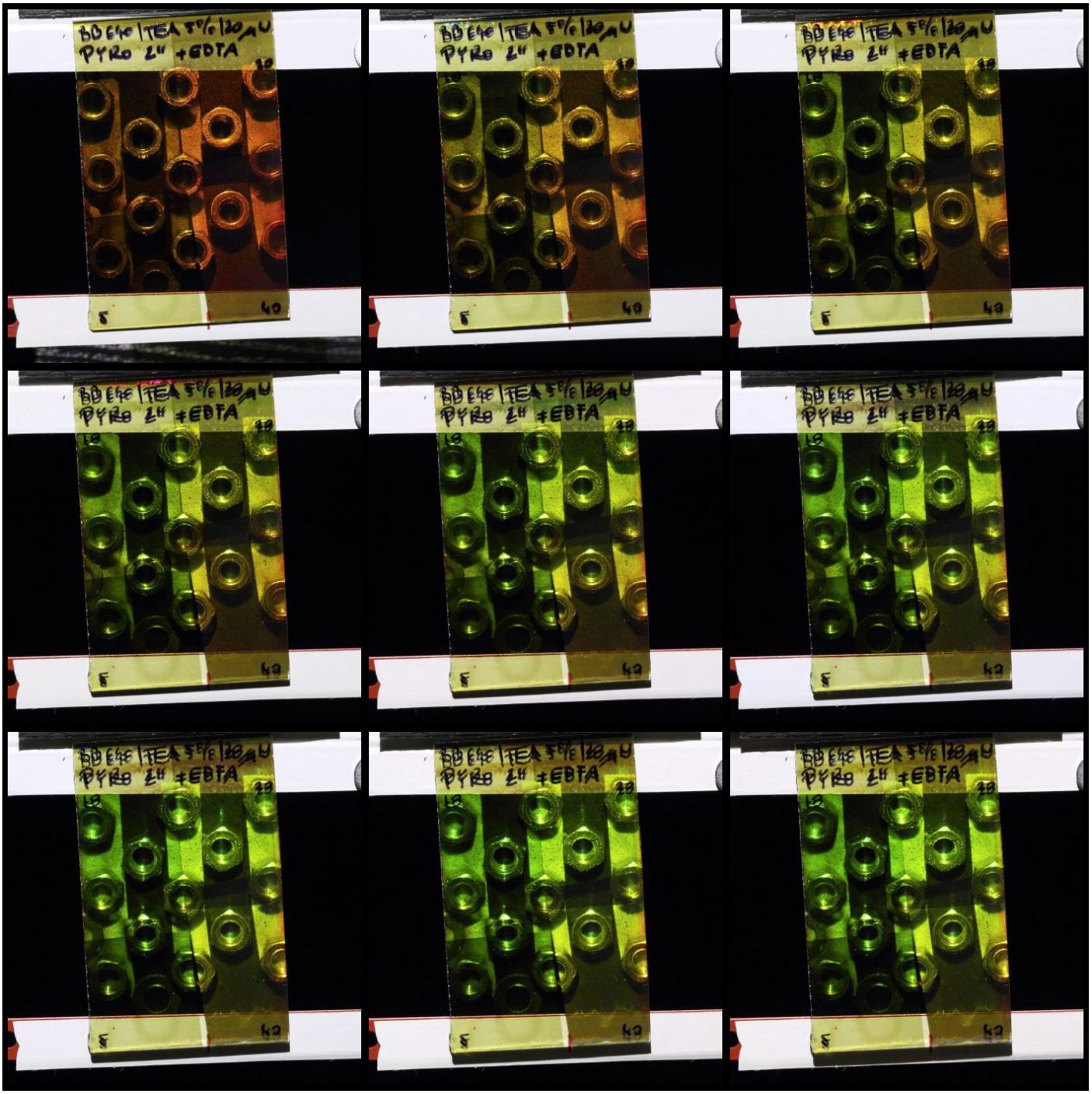
material	BB640 (Colour Holographic)
pre-treatment	TEA 5 %
developer	Pyrogallol (2')
bleach	Fe-EDTA
post-treatment	–
power	20 µW/cm^2
exposure	5 – 10 – 20 – 40 s
energy	100 – 200 – 400 – 800 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°

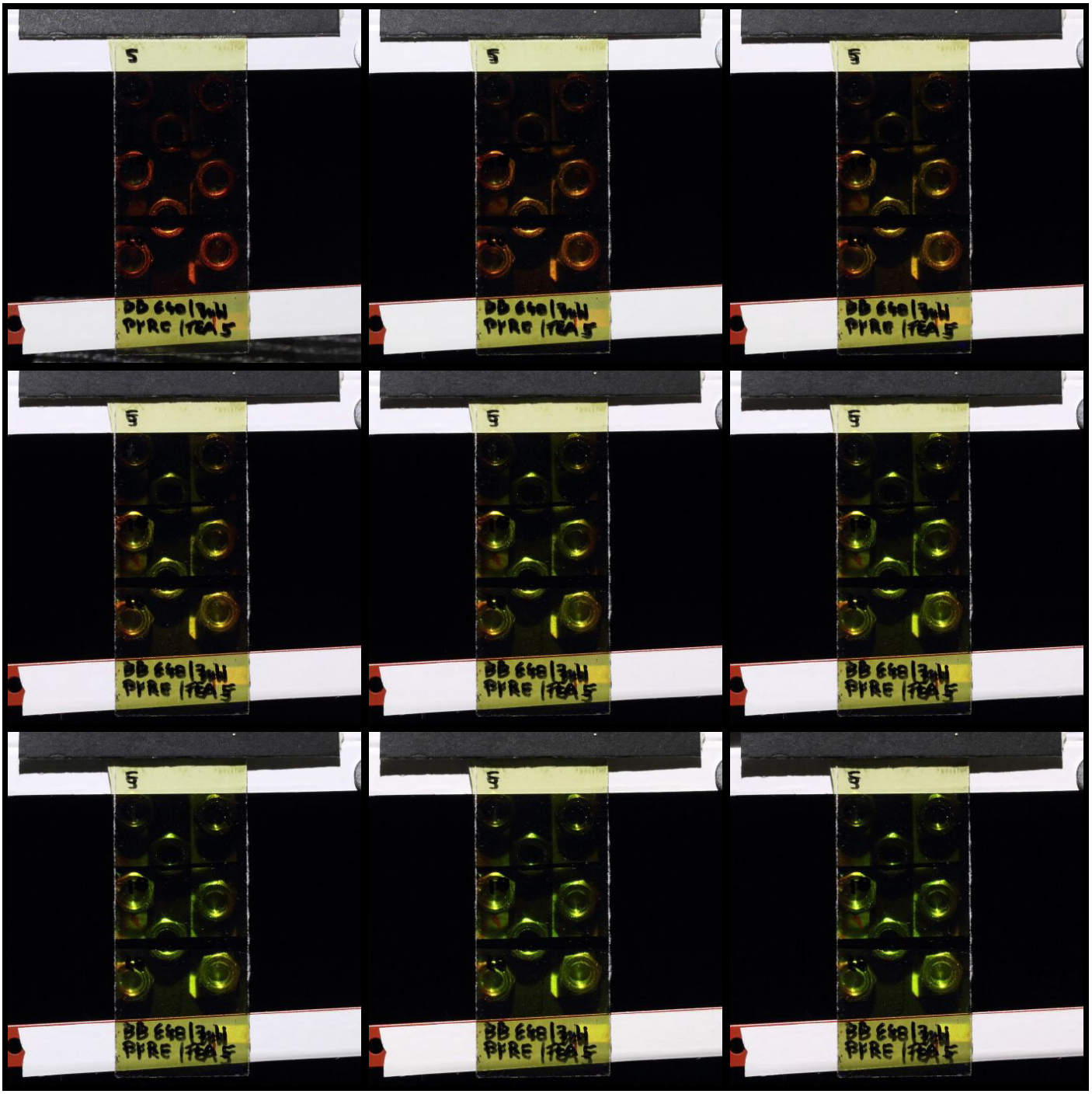


005 (3)

material	BB640 (Colour Holographic)
pre-treatment	TEA 5 %
developer	Pyrogallol (1')
bleach	Fe-EDTA
post-treatment	–
power	7 µW/cm^2
exposure	5 – 10 – 20 s
energy	35 – 70 – 140 µJ/cm^2

exposure (single image)
1 (low)
2
3 (high)

reconstruction wave angle with the normal (images layout)		
22°	31°	39°
45°	50°	54°
58°	61°	63°



006 (4)

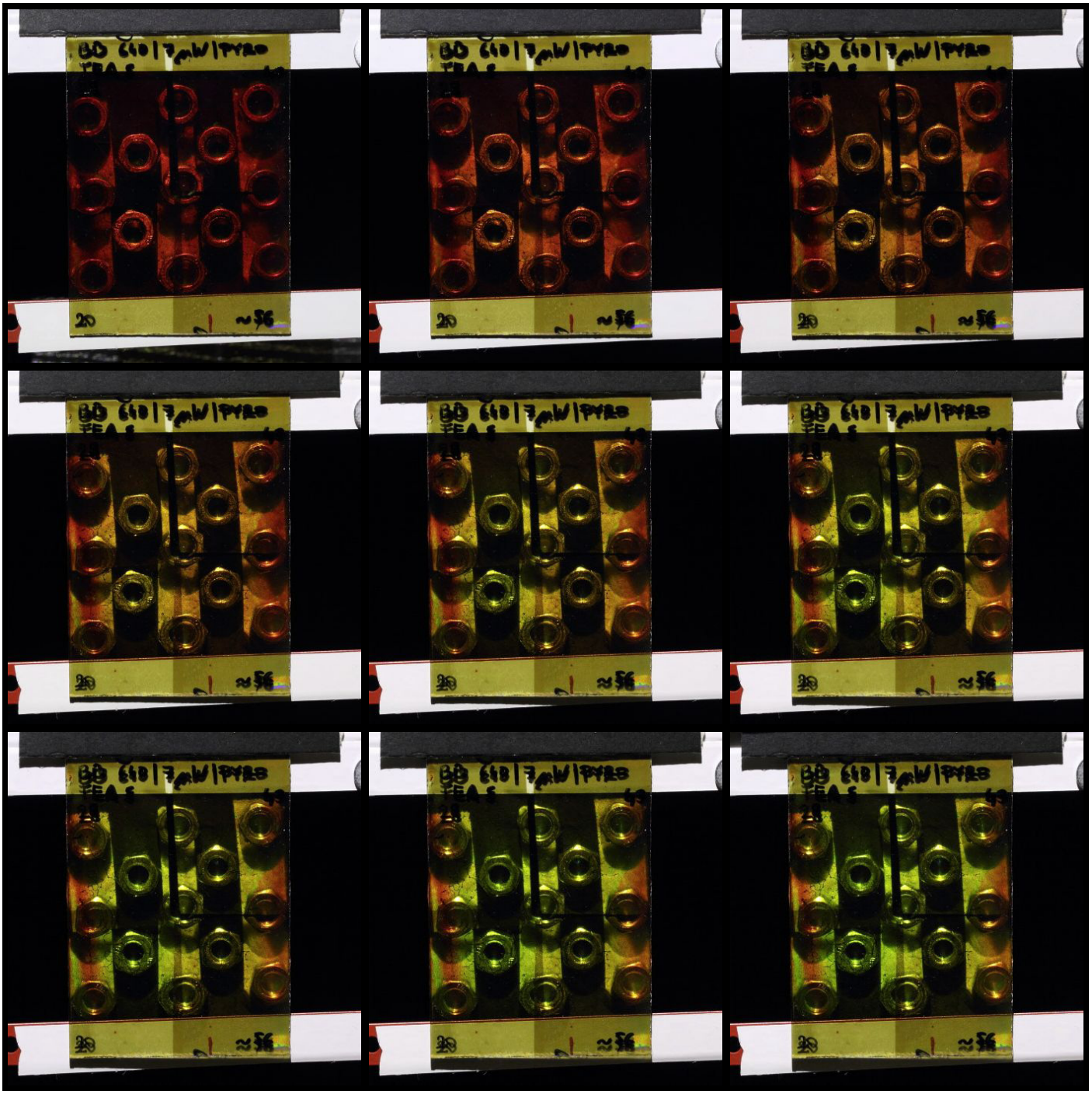
material	BB640 (Colour Holographic)
pre-treatment	TEA 5 %
developer	Pyrogallol (1')
bleach	Fe-EDTA
post-treatment	–
power	7 µW/cm^2
exposure	20 – 28 – 40 – 56 s
energy	140 – 200 – 280 – 400 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



007 (8)

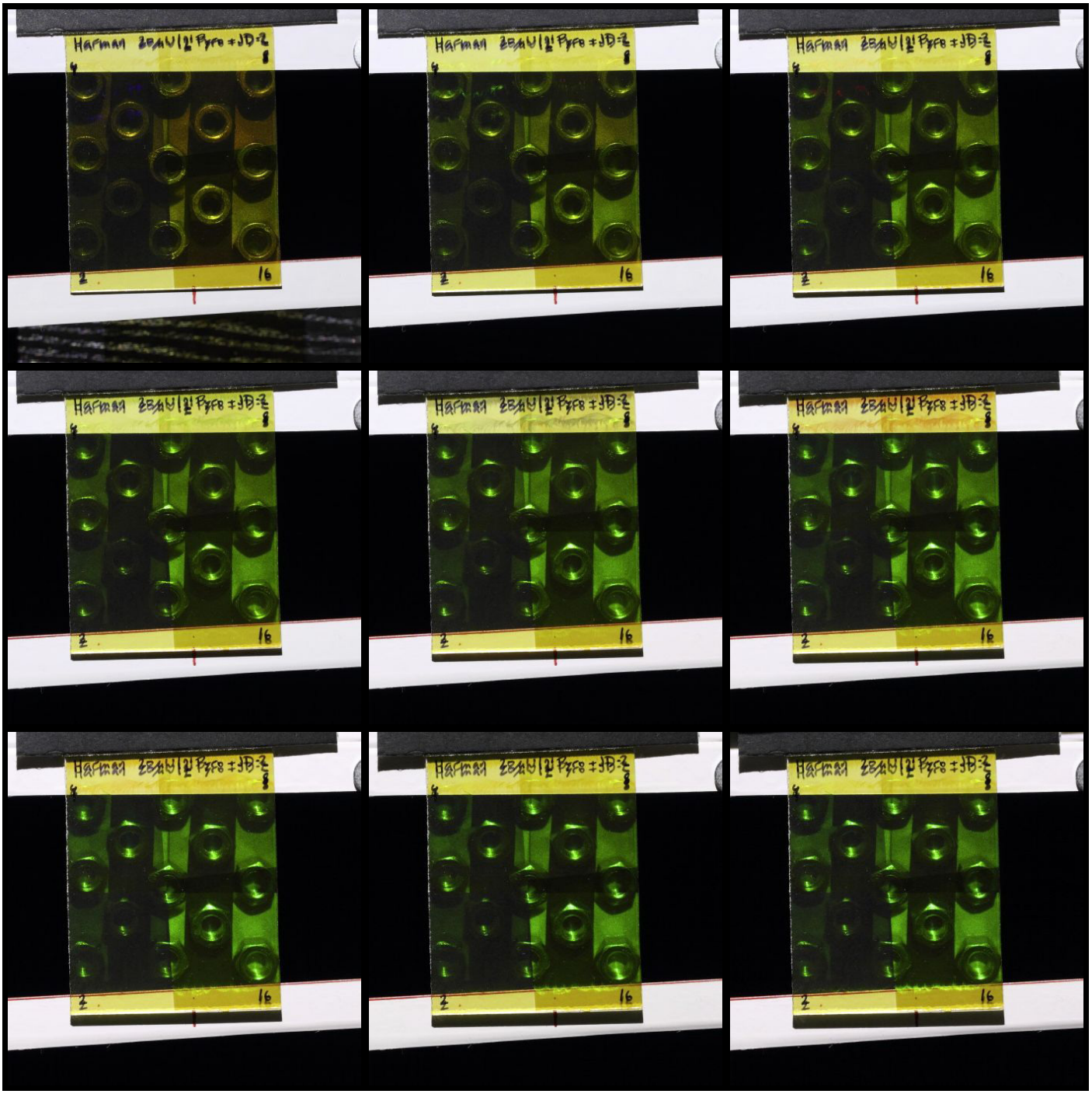
material	Harman HoloFX Red
pre-treatment	–
developer	Pyrogallol (2')
bleach	JD-2
post-treatment	–
power	20 µW/cm^2
exposure	2 – 4 – 8 – 16 s
energy	40 – 80 – 160 – 320 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



008 (7)

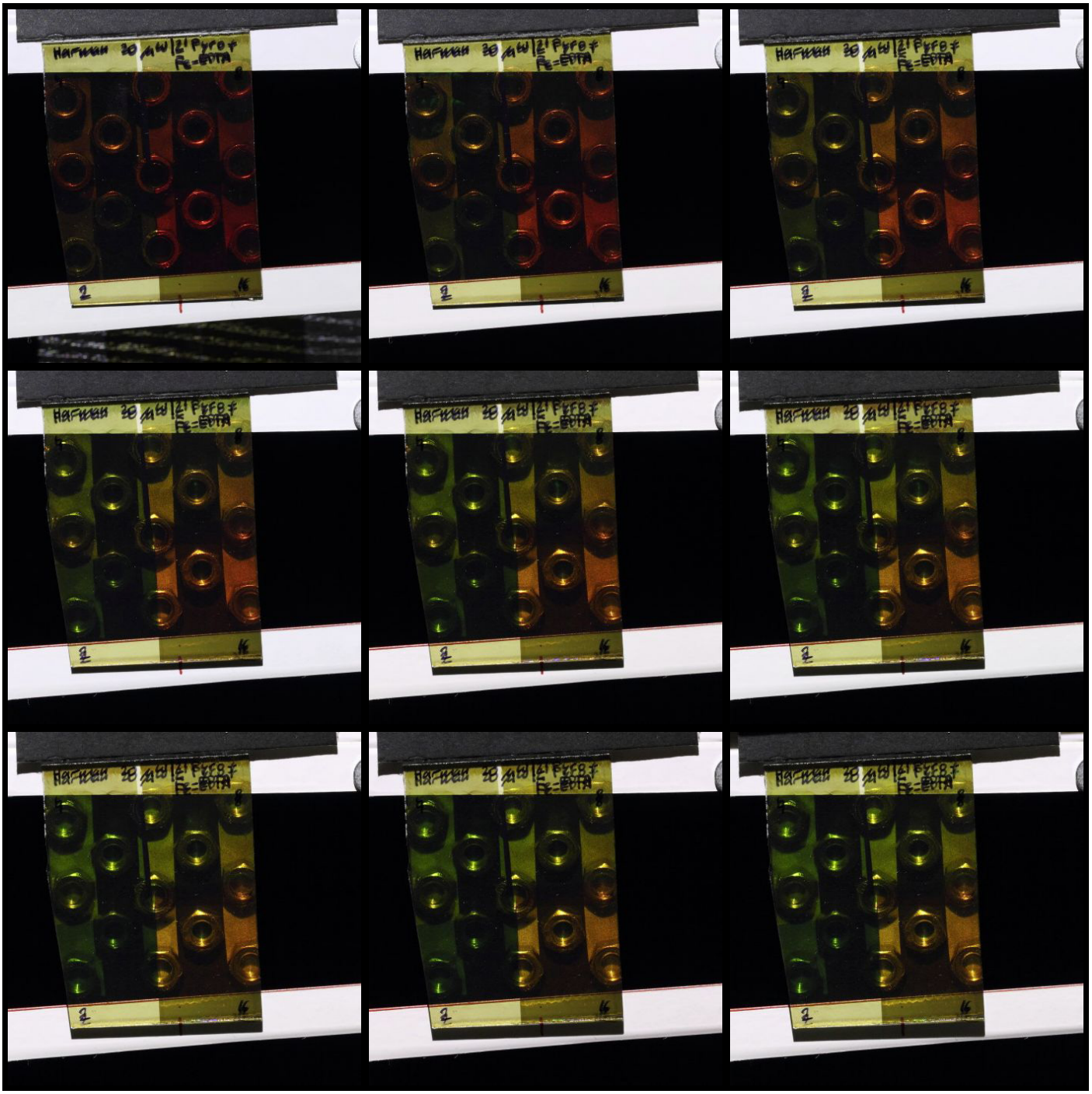
material	Harman HoloFX Red
pre-treatment	–
developer	Pyrogallol (2')
bleach	Fe-EDTA
post-treatment	–
power	20 µW/cm^2
exposure	2 – 4 – 8 – 16 s
energy	40 – 80 – 160 – 320 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



009 (9)

material	Harman HoloFX Red
pre-treatment	TEA 2.5 %
developer	Pyrogallol (1')
bleach	Fe-EDTA
post-treatment	–
power	7 µW/cm^2
exposure	2.5 – 5 – 10 – 20 s
energy	18 – 35 – 70 – 140 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°

010 (2)

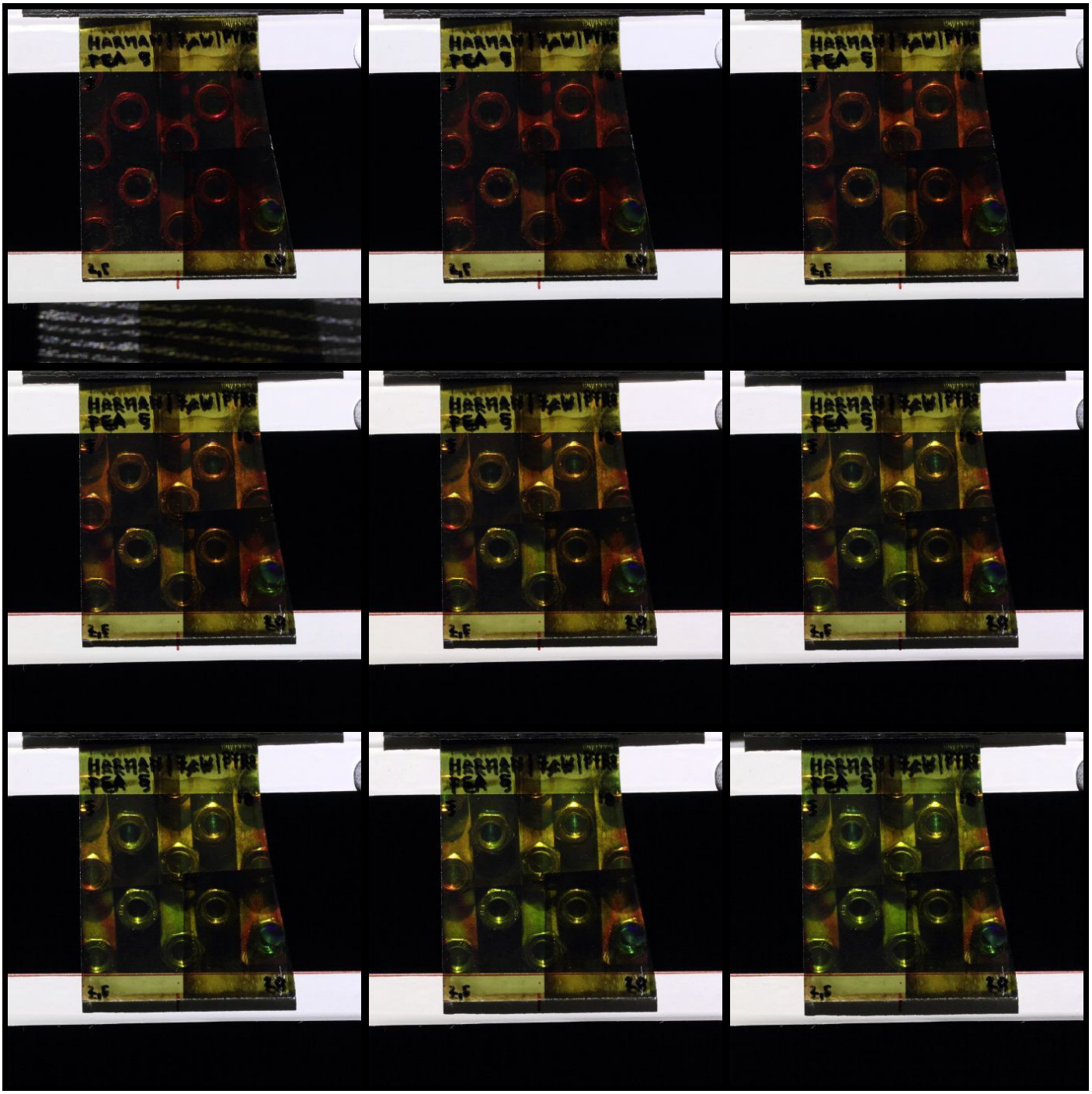
material	Harman HoloFX Red
pre-treatment	TEA 5 %
developer	Pyrogallol (1')
bleach	Fe-EDTA
post-treatment	–
power	7 µW/cm^2
exposure	2.5 – 5 – 10 – 20 s
energy	18 – 35 – 70 – 140 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



011 (6)

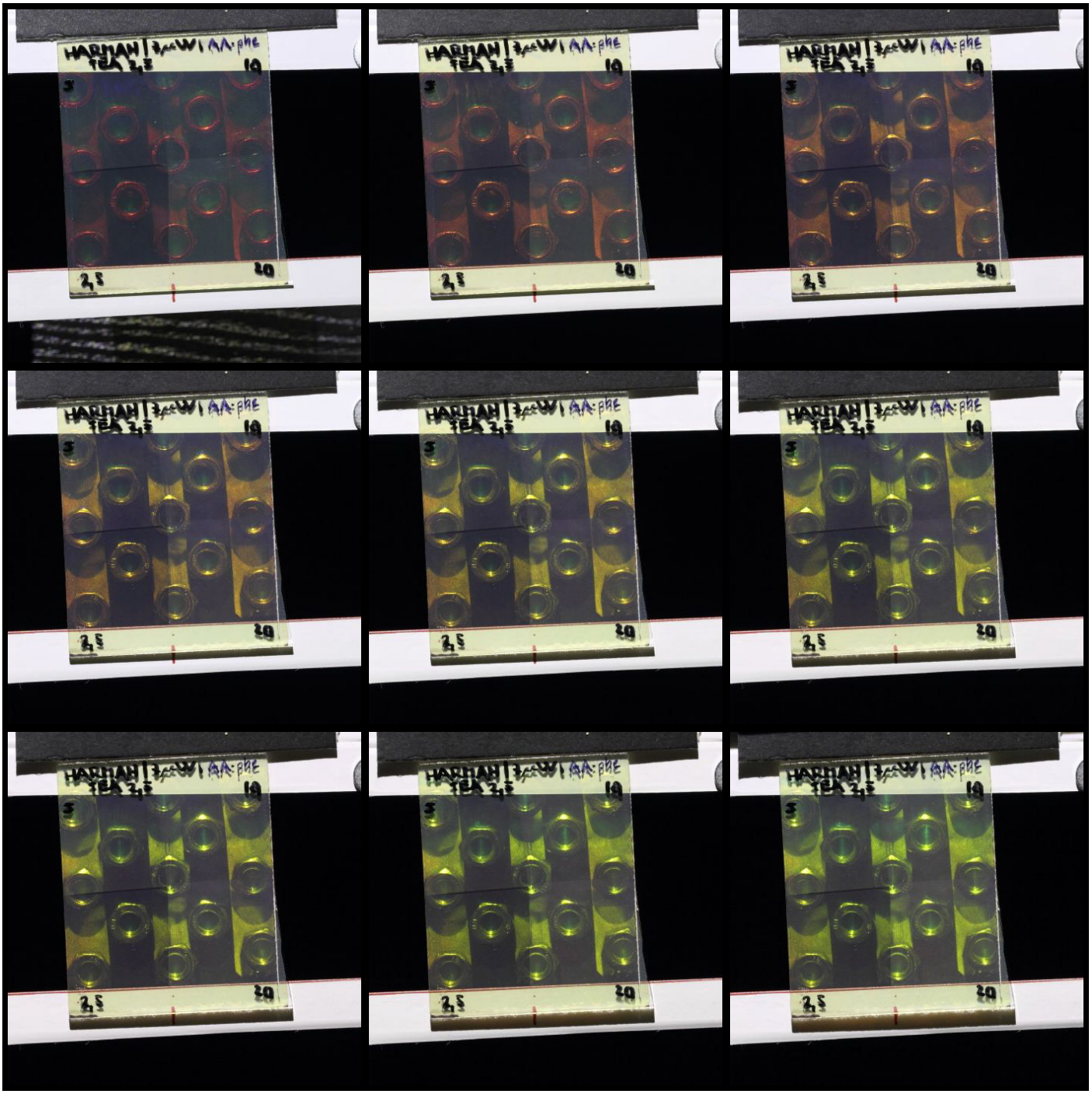
material	Harman HoloFX Red
pre-treatment	TEA 2.5 %
developer	AAP (1')
bleach	Fe-EDTA
post-treatment	–
power	7 µW/cm^2
exposure	2.5 – 5 – 10 – 20 s
energy	18 – 35 – 70 – 140 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



012 (5)

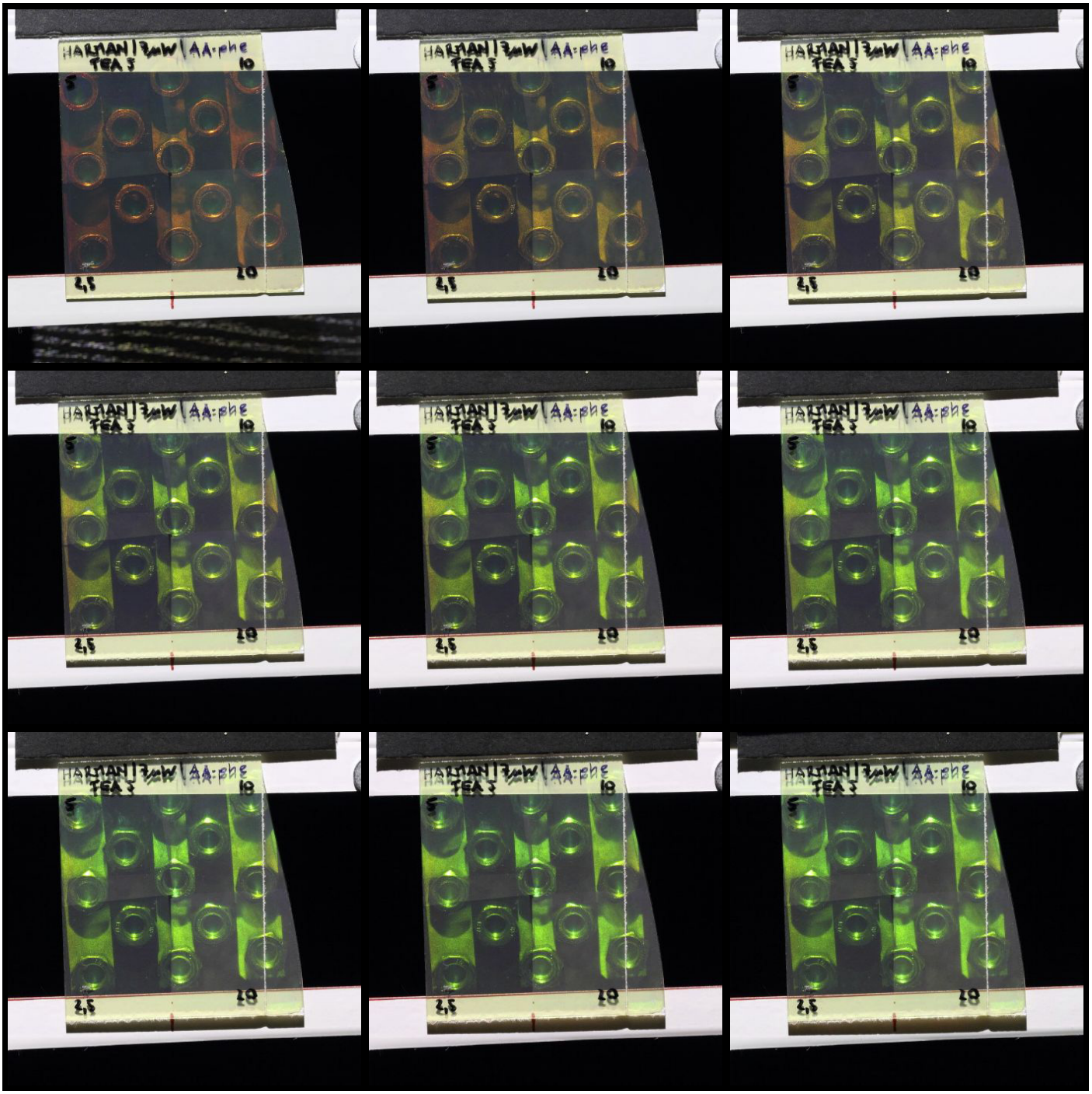
material	Harman HoloFX Red
pre-treatment	TEA 5 %
developer	AAP (1′)
bleach	Fe-EDTA
post-treatment	–
power	7 µW/cm^2
exposure	2.5 – 5 – 10 – 20 s
energy	18 – 35 – 70 – 140 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



013 (3)

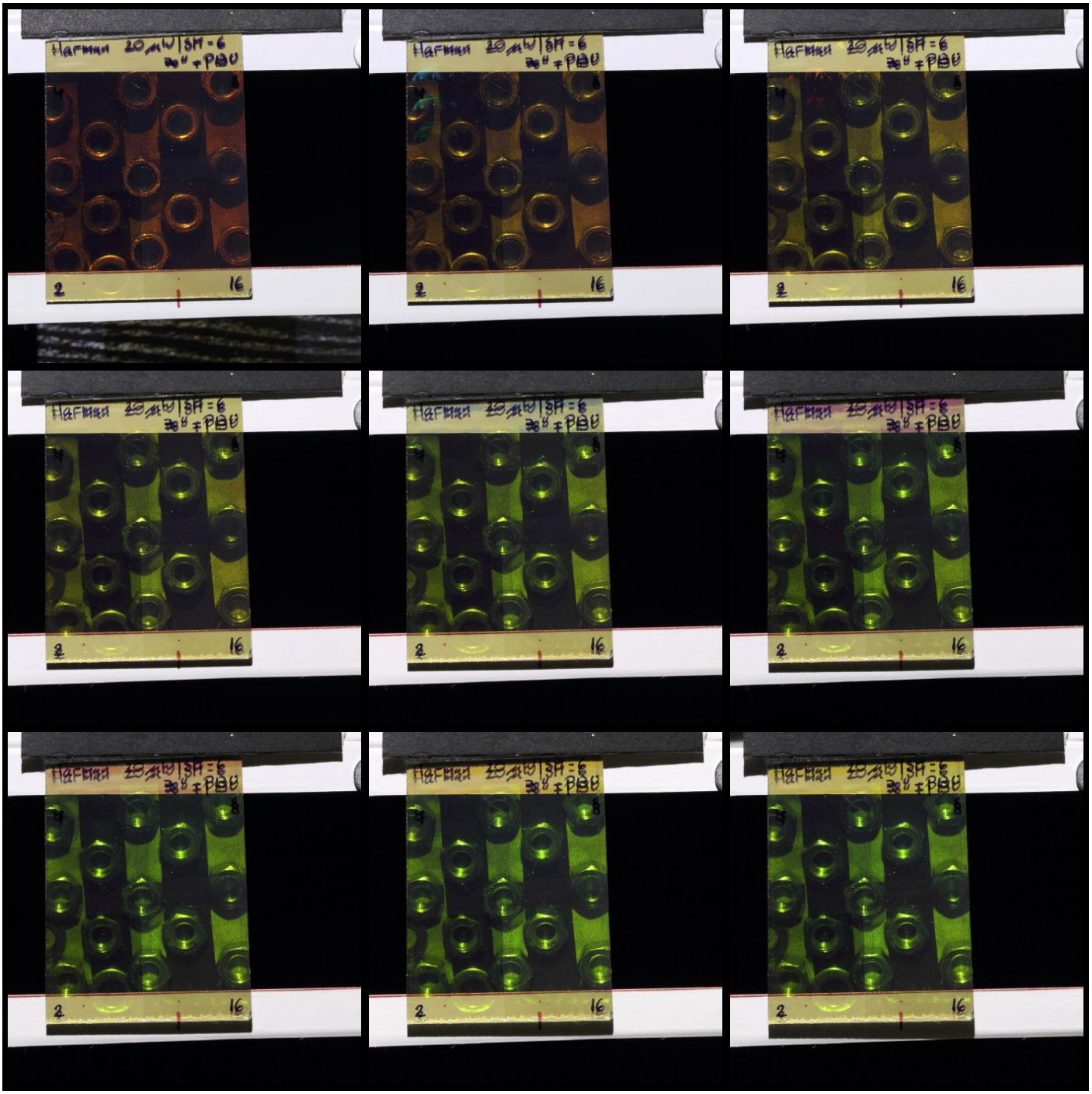
material	Harman HoloFX Red
pre-treatment	–
developer	SM-6 (70″)
bleach	PBU-Amidol
post-treatment	–
power	20 µW/cm^2
exposure	2 – 4 – 8 – 16 s
energy	40 – 80 – 160 – 320 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



014 (4)

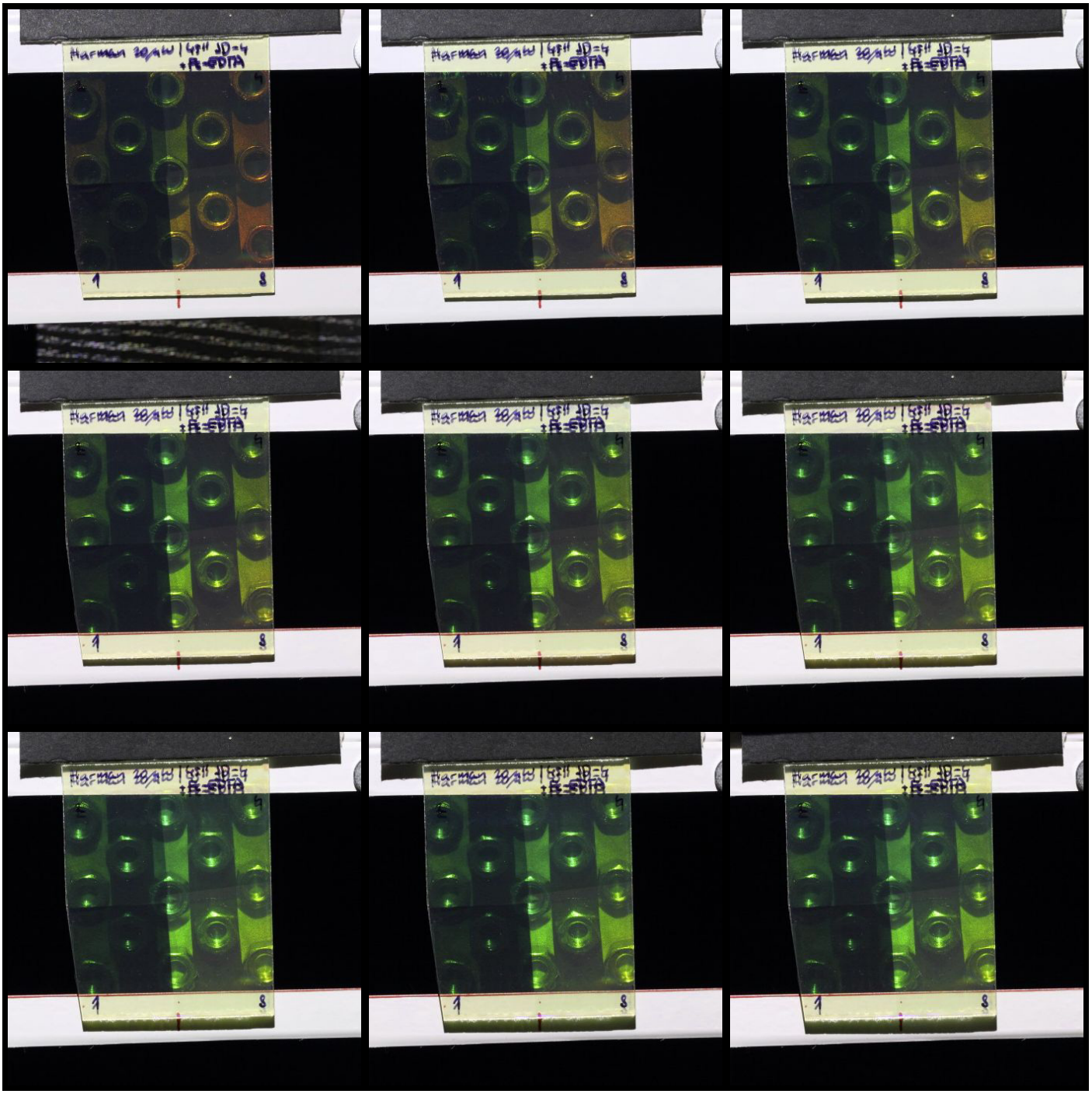
material	Harman HoloFX Red
pre-treatment	–
developer	JD-4 (45“)
bleach	Fe-EDTA
post-treatment	–
power	20 µW/cm^2
exposure	1 – 2 – 4 – 8 s
energy	20 – 40 – 80 – 160 µJ µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



015 (1)

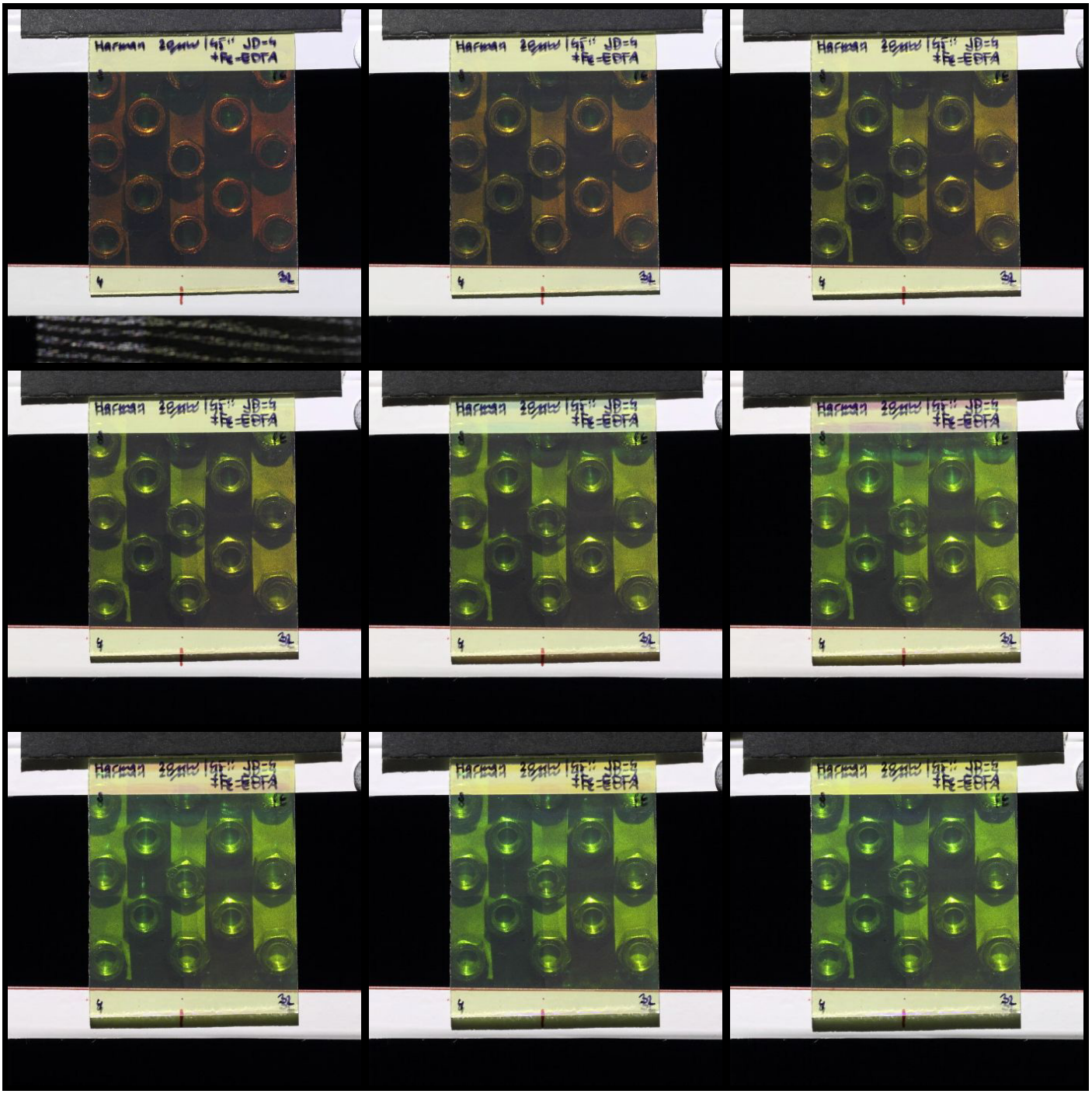
material	Harman HoloFX Red
pre-treatment	–
developer	JD-4 (45“)
bleach	Fe-EDTA
post-treatment	–
power	20 µW/cm^2
exposure	4 – 8 – 16 – 32 s
energy	80 – 160 – 320 – 640 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°



016 (10)

material	Harman HoloFX Red
pre-treatment	–
developer	JD-4 (45“)
bleach	JD-4
post-treatment	–
power	20 µW/cm^2
exposure	2 – 4 – 8 – 16 s
energy	40 – 80 – 160 – 320 µJ/cm^2

exposure (single image)

2	3
1 (low)	4 (high)

reconstruction wave angle with the normal (images layout)

22°	31°	39°
45°	50°	54°
58°	61°	63°