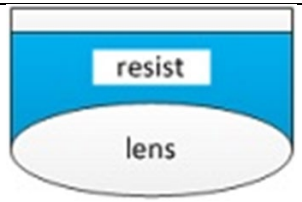
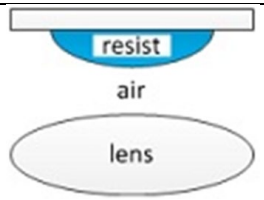
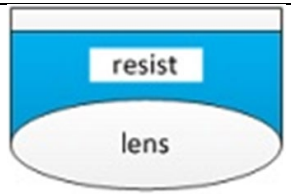
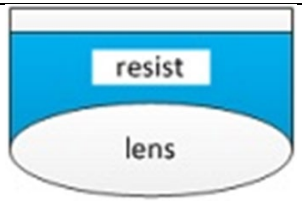
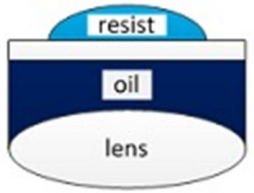
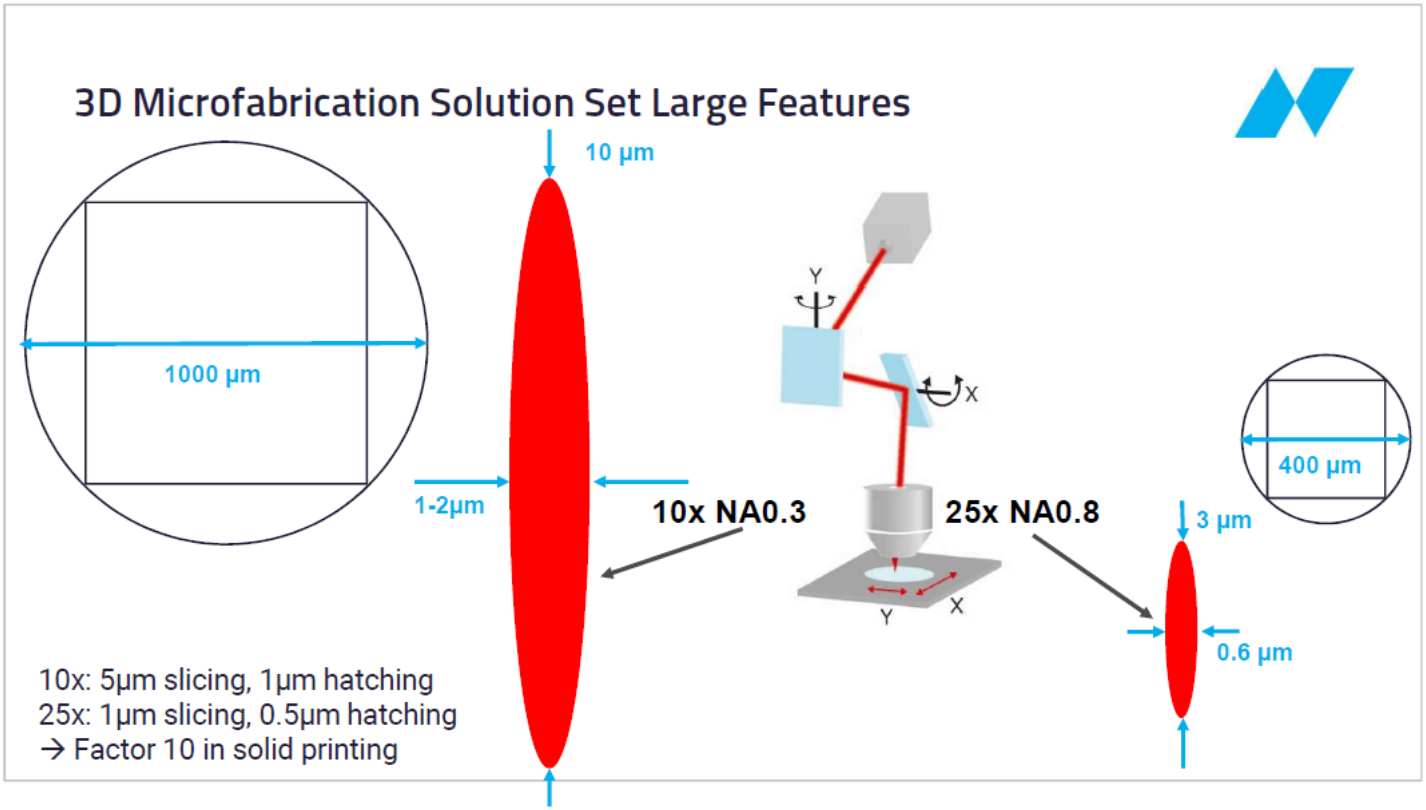
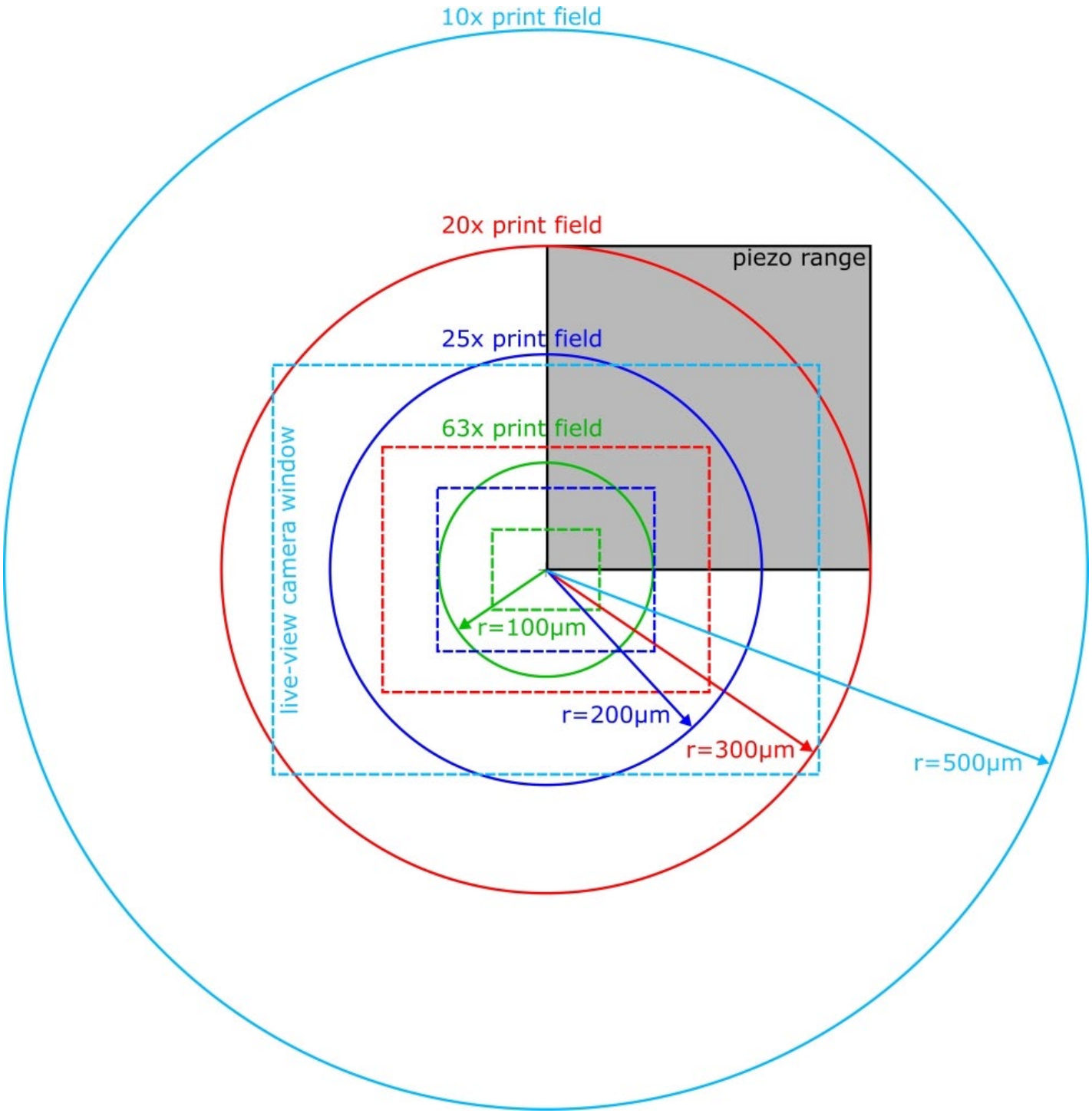
Objective					
Mag, WD	10x, 700um	20x	25x, 380um	63x, 190um	63x
					
Application area	um to mm 3D	2D-2.5D	um to mm 3D, smooth 3D	0.2um to 10's of microns 3D	New materials, 0.2um to 10's um
NA	0.3	0.5	0.8	1.4	1.4
Micro. Pos.	4	5	1	3	3
Max block area sq	825x825	425x425	285x285 sq	140x140	140x140
Max block diam	1000 (up to 1.7mm dia, IPVisio 15000 speed, 100%, 1.3 power scaling)	600	400	200	200
Min feature size (um)	~2um x,y ~10um z, but freestanding features <20um will deform	~1um x,y ~6um z	~0.6um x,y ~3.3um z	~150nm x,y, ~800nm z	
Min spacing between features um	6-7um (10um recommended)	1um	1um	150nm	
Max feature height (um)	8mm(IPQ)	Thickness of PR	~3mm (IP-S)	~3mm (IP DIP)	~150um (w/170um glass)

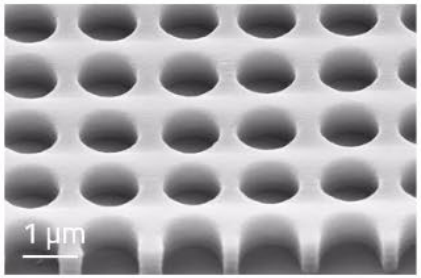
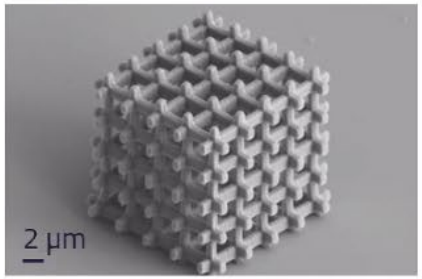
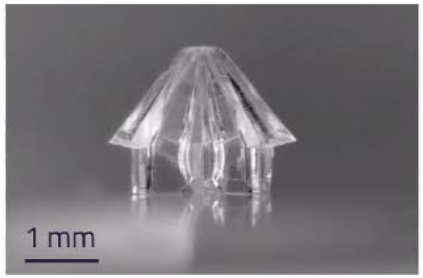
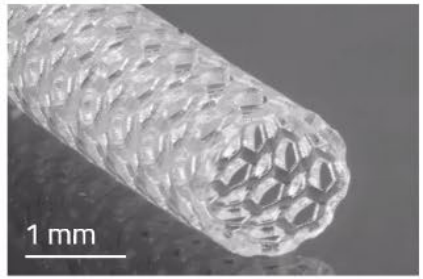
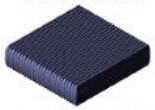
Typ. Scan Speed mm/s	100	2-8	100	100	20
Max write area (mm)			25mm ITO: ~17mm recommended max		
Objective					
Write speed	6.8 mm^3/hr, (for shell/scaffold) 9min/mm^3		Shell: .77 mm^3/hr, 1.3h/mm^3 Solid: .11 mm^3/hr, 9h/mm^3	Solid: .0017 mm^3/hr 24days/mm^3	
Working Dist (um)	700	2100 (air only, oil and dip-in not allowed)	380 Dip In 190 Oil	360 Dip In 170 Oil	360 Dip In 170 Oil
Immersion Medium	IP-Q (n=1.487 @ 589nm)	Air	IP-S (n=1.48 @780nm)	IP Dip (n=1.52)	Oil
Resist Resins	IP-Q, IP-Visio, IP-PDMS, GP-Silica, IP-Visio, IP-n162	AZ, SU8, Ormocorp	IP-S, IP-Visio, IP-PDMS, GP-Silica, IP-Visio, IP-n162	IP-Dip, IP-Visio	IP-L, IP-G
Substrates	Silicon, other substrates with manual focus	Silicon, glass	ITO Glass (n=1.624, 700um thick), Silicon (n=3.71)	Fused Silica (n=1.45), silicon	Borosilicate glass (n=1.52) 170um thick (coverslip)
Slicing (um)	5	3-6 um	1 (0.2-1.0)	0.5 (0.1-0.5)	0.5
Hatch (um)	1	0.7-1.2 um	0.5 (0.2-0.5)	0.2 (0.1-0.5)	0.2

Photoresist Orientation	Z=1 (Dill,PR on bottom)	Z=1 (Air, PR on bottom facing objective)	Z=1 (Dill,PR on bottom facing objective)	Z=1 (Dill,PR on bottom)	Z=0 (Oil, PR on top)

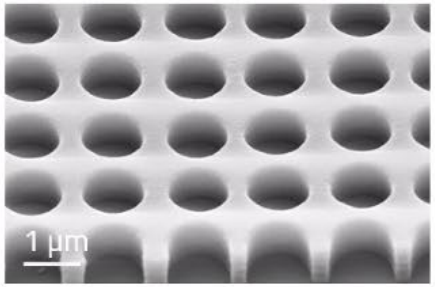
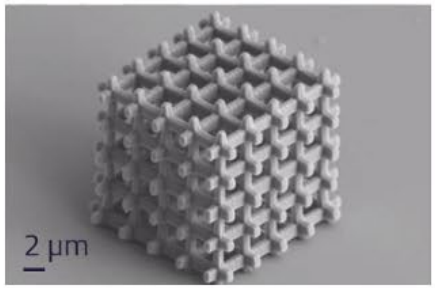
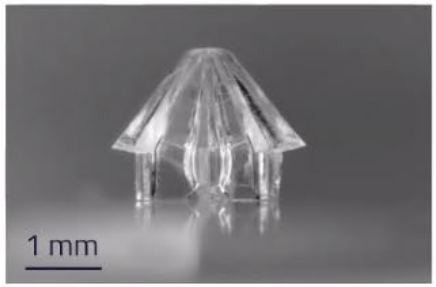
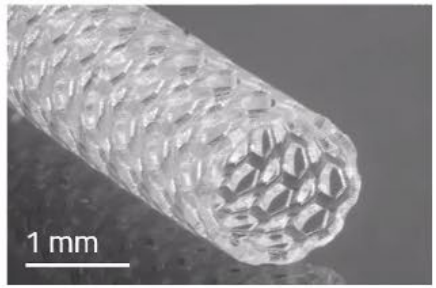



10x print field
20x print field
piezo range
25x print field
63x print field
live-view camera window
r=100µm
r=200µm
r=300µm
r=500µm

Print Sets – Recommendations

2D Maskless Lithography	3D Small Features	3D Medium Features	3D Large Features
2D High Aspect Ratio Printing with AZ-Resin	Highest 3D Resolution and Shape Accuracy	3D Smooth Surfaces and High Shape Accuracy	3D High-Speed Printing of Millimeter Parts
			
Recommendations			
Max Area  < 100 cm²	Max Volume  < 0.1 mm³	Max Volume  < 50 mm³	Max Volume  < 400 mm³
Voxel Ø ~ 1 µm 	Voxel Ø ~ 0.2 µm 	Voxel Ø* ~ 0.6 µm 	Voxel Ø* ~ 1.2 µm 
20x	63x	25x	10x

Print Sets – Print and Recipe Parameters

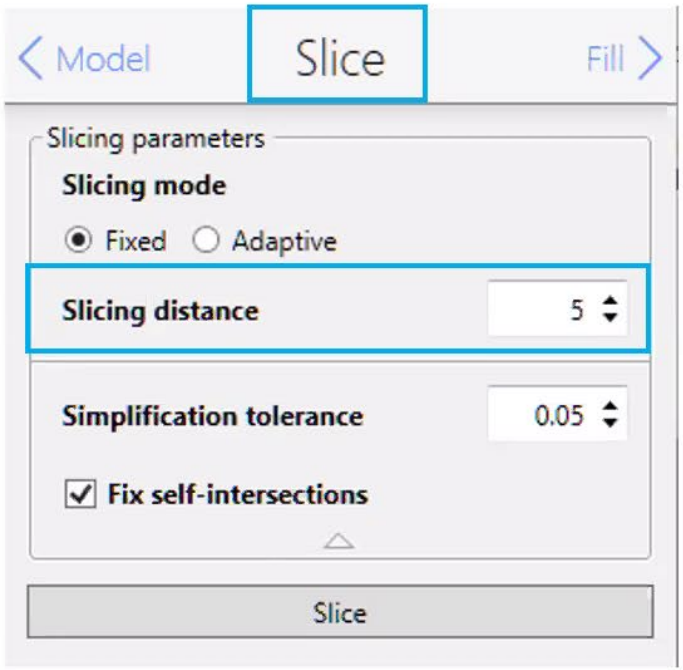
	2D Maskless Lithography	3D Small Features	3D Medium Features	3D Large Features
Print Parameters	Print Field: Ø 600 µm Print Time: 7.6 mm²/h	Print Field: Ø 200 µm Print Time: 0.04 mm³/h	Print Field: Ø 400 µm Print Time: 0.8 mm³/h*	Print Field: Ø 1000 µm Print Time: 6.8 mm³/h*
				
Recipe Parameters	Slicing / Hatching	Slicing / Hatching	Slicing / Hatching	Slicing / Hatching

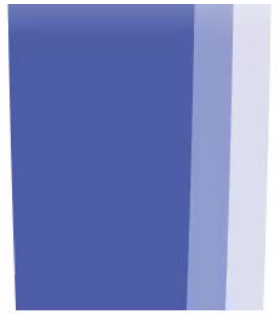
Large Features

- 1–400 mm^3 print volume
- Stable features 20 µm or larger
- Structures up to 8 mm tall
- Stitch-free Ø < 1000 µm

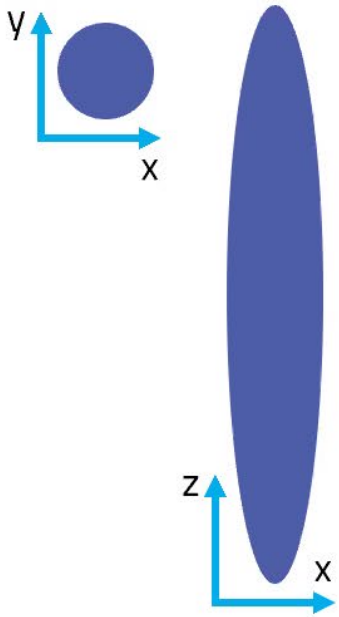
- Typical applications:
  - Microfluidic pick-and-place parts
  - Rotors/stators for material analytics
  - Scaffolds for tissue engineering

Slicing Distance

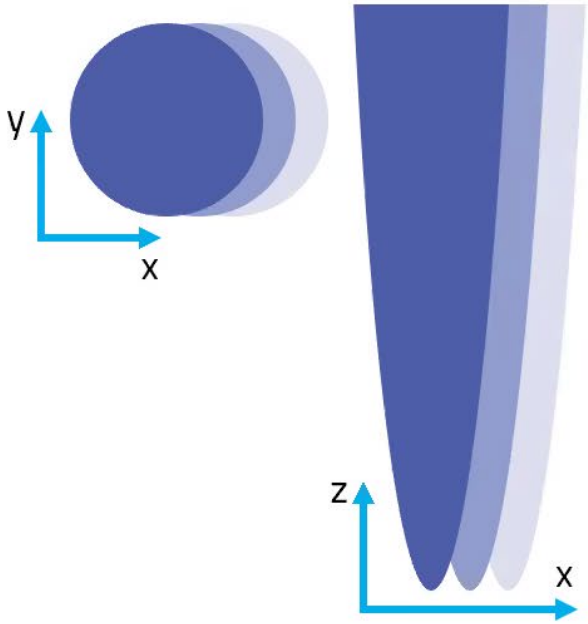




3D MF (25x obj. + IP-S):
- xy Ø ≈ 0.6 µm*
- Aspect Ratio (AR) ≈ 6



3D LF (10x obj. + IP-Q):
- xy Ø ≈ 1.2 µm*
- Aspect Ratio (AR) ≈ 10



Objectives options

	63x NA 1.4	25x NA 0.8	20x NA 0.5
Structural Characteristics	High 3D resolution	High 3D smoothness	High 2D resolution
Immersion Medium	IP-Dip/Oil	Resin	Air
Working Distance	360 – 170 µm†	380 µm	2100 µm
Writing Field	200 µm	400 µm	600 µm
Standard Resin	IP-Dip/IP-L	IP-S	AZ resists
Refractive Index Contrast	>0.04	>0.1	-
Typ. Slicing Distance	*500 nm*	*1000 nm*	-
Typ. Hatching Distance	*200 nm*	*300 nm*	-

†Working distance depends on configuration and substrate height.

Resin and resists options

Immersion Configurations

Name	Refractive Index*	Phase	Structure Characteristics	Printing Mode	Configuration
IP-L 780	1.48	Liquid	High resolution	Oil	63x/Cover slip
IP-G 780	1.49	Gel	Flying features	Oil	63x/Cover slip
IP-Dip	1.51	Liquid	High resolution	DiLL	63x/Fused silica
IP-S	1.48	Liquid	High smoothness	DiLL	25x/ITO glass

Air Configurations

Name	Refractive Index	Phase	Resist Tone
AZ resists	1.6173 – 1.6953†	Solid	Positive
SU-8	1.58	Solid	Negative
Ormocomp	1.52	Liquid	Negative

* Measured at 20°C at 780 nm.
† Refractive index depends on the specific resist and wavelength. Unbleached values at 405 nm are shown here.

2PP resin	Refractive index	Phase	Characteristics	Print Set	Objective	Substrate
IP-Dip	1.521	liquid	high resolution	3D SF	63x	fused silica (3D SF DiLL), silicon (3D LF DiLL)
IP-L 780	1.485	liquid	high resolution	3D SF Oil	63x	borosilicate (3D SF Oil)
IP-G 780	1.495 before bake	gel	high resolution, flying features	3D SF Oil	63x	borosilicate (3D SF Oil)
IP-S	1.486	liquid	high smoothness, mesoscale	3D MF	25x	ITO-coated (3D MF DiLL), silicon (3D LF DiLL)
IP-Q	1.487	liquid	mesoscale	3D LF	10x	silicon (3D LF DiLL)
IP-Visio	1.486	liquid	low fluorescence, non-cytotoxic	3D MF	25x	ITO-coated (3D MF DiLL)
AZ 5214E	1.6990	solid	2D lithography	2D ML	20x	silicon (3D LF DiLL)
AZ 9260	1.6963	solid	2D lithography	2D ML	20x	ITO-coated (3D MF DiLL)
AZ MIR 701	1.7039	solid	2D lithography	2D ML	20x	fused silica (3D SF DiLL)
AZ 40XT	1.5851	solid	2D lithography	2D ML	20x	silicon (3D LF DiLL)
SU-8	1.58	solid	2D lithography	2D ML, 3D SF Oil	20x, 63x	fused silica (3D SF DiLL), silicon (3D LF DiLL), borosilicate (3D SF Oil)
Ormocomp	1.520	liquid	transparent	2D ML, 3D SF Oil	20x, 63x	fused silica (3D SF DiLL), silicon (3D LF DiLL), borosilicate (3D SF Oil)

Other 2PP resins used with the **Nanoscribe** 3D printer.

2PP resin	Refractive index	Phase	Characteristics	Print Set	Objective	Substrate
AZ 1500	1.7123	solid	2D lithography	2D ML	20x	fused silica (3D SF DiLL), silicon (3D LF DiLL)
AZ 6600	1.7112	solid	2D lithography	2D ML	20x	fused silica (3D SF DiLL), silicon (3D LF DiLL)
AZ ECI 3027	1.7014	solid	2D lithography	2D ML	20x	fused silica (3D SF DiLL), silicon (3D LF DiLL)
AZ nLOF	1.6389	solid	2D lithography	2D ML	20x	fused silica (3D SF DiLL), silicon (3D LF DiLL)

10x Objective

Use the 10x immersion objective for printing large features in conjunction with the IP-Q resin.

A resin stop is required (supplied with the 3D LF). This prevents 2PP resin from creeping into the objective nosepiece.

Property	Value	Comments
Objective	10x NA 0.3	see also objective overview
Immersion (DiLL) mode	yes	
Immersion media	2PP resin	IP resins from Nanoscribe are safe to use with the objective
Working distance *WD*	700 µm	
Objective opening angle a	35°	
Objective lens diameter *D*	2.5 mm	
Felt ring	not available	use the dedicated resin stop to prevent damage to the printer
Printing field (Galvo Ø)	1000 µm	stage movement allows for a larger effective printing field
Theoretical lateral (a_{xy}) and axial resolution (a_z);[ref] [aspect ratio]	$a_{xy} = 1.6$ µm; $a_z = 25.4$ µm; 16.0	for 780 nm laser wavelength, IP-Q and 20°C; voxel size and line width depend on solution set and print parameters; single lines are very unstable (high aspect ratio; see article for more information)
Standard 2PP resin	IP-Q	
Solution set	3D LF	
Δn required @ 830nm	>0.5	required substrate thickness to distinguish between two interface signals: >700 um (because of the large depth of focus)
Typical slicing distance	5 µm	standard recipe for IP-Q
Typical hatching distance	1 µm	

25x Objective

The 25x immersion objective is used for printing medium-sized features. The best surface smoothness is achieved in conjunction with IP-S, hence this objective is recommended for printing micro-optics.

A felt ring is available that prevents 2PP resin from creeping into the objective nosepiece.

Two versions of this objective are in use. Each has equivalent optical performance, but differs in shape and felt ring size as well as an additional "SIL" (silicone oil) marking on the adjustment ring for the latest version. The position of the adjustment ring markers are also mirrored compared to the previous objective revision.

Table 1: Objective properties

Property	Value	Comments
Objective	25x NA0.8	see also objective overview
Immersion (DiLL) mode	yes	
Immersion media	oil/glycol/water/2PP resin	Most IP resins from Nanoscribe are safe to use with this objective
Working distance *WD*	380 µm	
Objective opening angle *a*	31°	
Objective lens diameter *D*	5.2 mm	
Felt ring size	30 mm / 32 mm	depending on objective version
Printing field (Galvo Ø)	400 µm	stage movement allows for a larger printing field
Theoretical lateral (a_{xy}) and axial resolution (a_z);[ref] [aspect ratio]	a_{xy} = 595 nm, a_z = 3313 nm; 5.6	for 780 nm laser wavelength, IP-S and 25°C; voxel size and line width depend on solution set and print parameters
Standard 2PP resin	IP-S	
Solution set	3D MF	
Δn required @ 830nm	>0.1	
Typical slicing distance	1 µm	standard recipe for IP-S
Typical hatching distance	0.5 µm	

63x Objective

The 63x immersion objective is the objective for printing small features. For printing the finest features possible, IP-Dip and IP-L 780 are recommended.

A felt ring prevents 2PP resin or oil creeping into the objective nosepiece.

Property	Value	Comments
Objective	63x NA1.4	see also objective overview
Immersion (DiLL) mode	yes	
Immersion medium	oil/2PP resin	with the exception of IP-G (780), IP resins from Nanoscribe are safe to use as immersion medium
Working distance *WD*	360 µm (-170 µm)	when working in oil immersion configuration, the range is reduced by 170 µm owing to the substrate thickness
Objective opening angle *a*	12°	
Objective lens diameter *D*	5.5 mm	
Felt ring size	22.5 mm	
Printing field (galvo Ø)	200 µm	stage movement allows for a larger printing area
Theoretical lateral (a_{xy}) and axial resolution (a_z);[ref] [aspect ratio]	a_{xy} = 340 nm, a_z = 826 nm; 2.4	for 780 nm laser wavelength, IP-Dip and 25°C; voxel size and line width depend on solution set and print parameters
Standard 2PP resin	IP-Dip	IP-L 780 or IP-G 780 are also suitable
Solution set	3D SF	or 3D SF Oil
Δn required @ 830nm	>0.04	
Typical slicing distance	0.3 µm	standard recipe for IP-Dip
Typical hatching distance	0.2 µm	

20x Objective

The 20x objective is the air objective for 2D and 2.5D lithography. AZ resins give good results in structuring thin- and thick-film resists.

Table 1: Objective properties

Property	Value	Comments
Objective	20x NA0.5	see also objective overview
Immersion (DiLL) mode	no	therefore no felt ring required
Working distance	2100 µm	
Printing field (galvo Ø)	600 µm	stage movement allows for a larger printing field
Theoretical lateral (a_{xy}) and axial resolution (a_z);[ref] [aspect ratio]	a_{xy} = 951 nm, a_z = 5824 nm; 6.1	for 780 nm laser wavelength and air; voxel size and line width depend on print set and print parameters
Standard resin	AZ	
Print set	2D ML	
Δn required	no limitation	typically the interface between substrate and air is found
Typical slicing distance	3-6 µm	standard recipe for AZ resins
Typical hatching distance	0.7-1.2 µm	