

Gratings for phase contrast imaging / Standard specifications

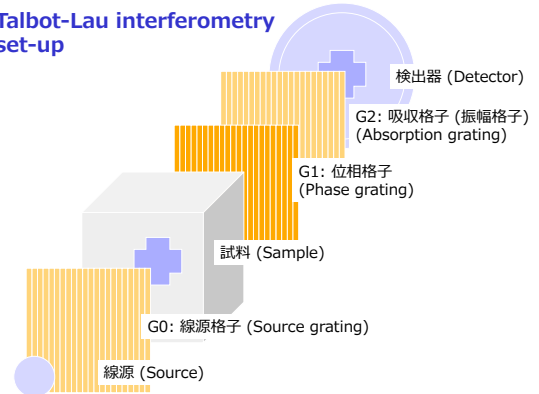
KIT offers X-ray gratings with a high aspect ratio based on the LIGA process

Talbot interferometry set-up: Using an ordinary X-ray tube, three gratings are required. G0: For spatial coherence (not used in the Talbot-Lau set-up using SR light), G1: Phase grating, G2: Absorption grating (Amplitude grating).

Talbot-Lau interferometry set-up: Using a coherent source like an SR beam, two gratings are required. G1: Phase grating, G2: Absorption grating (Amplitude grating)

KIT/IMT develops and fabricates G0, G1, and G2, taking advantage of the **LIGA process** - X-ray irradiation of resist through a precise X-ray mask, and grids after development are filled with metal by electroplating.

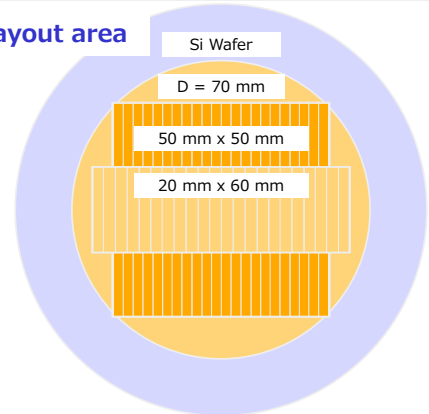
Talbot-Lau interferometry set-up



Standard specifications

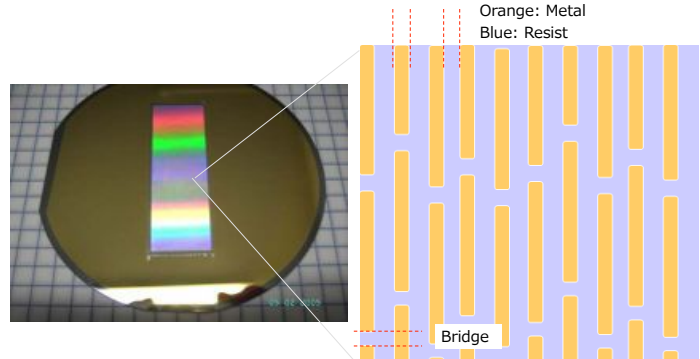
Structure material	Au, Ni, or polymer
Substrate material	4 inch Si wafer (550 μm, optional 200 μm), further options available
Tolerance	Duty cycle +/- 10%, Height 10% (over the wafer)
Wall roughness	< 50 nm
Max. line length	Depends on the aspect ratio
Layout area (standard)	D = 70 mm, 50 mm x 50 mm, 20 mm x 60 mm Larger size under development
Material and thickness of the wafer negotiable. Material and height of the structure can be proposed considering the set-up.	

Layout area



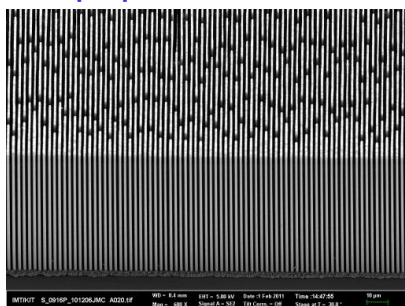
Structure examples

	G ₀ , G ₂	G ₀ , G ₂	G ₀ , G ₂	G ₁
Height	100 μm	150 μm	200 μm	4 μm
Period	2.4 μm	4.8 μm	10 μm	3.57 μm
Material	Au	Au	Au	Ni

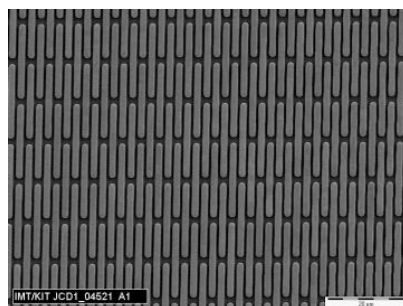


Right: Schematic of magnified grating structures. To obtain a high aspect ratio, resist bridges are required during the fabrication process. In the end resist bridges (e.g. 2-3 μm width) appear every 30-45 μm in metal lines.

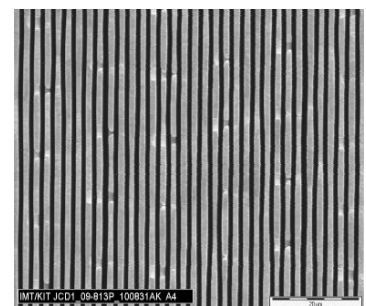
Example pictures



Au, Period: 2.4 μm, Height: 120 μm



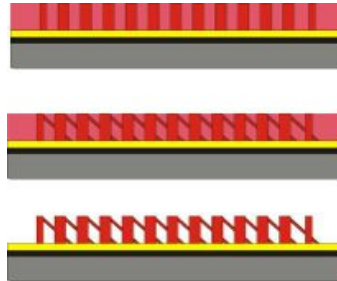
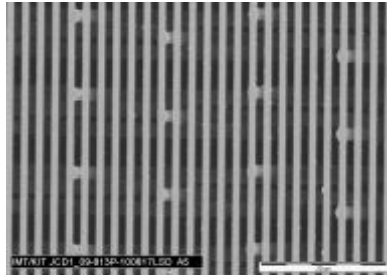
Au, Period: 4.37 μm
Line length: 30 μm, Bridge: 2 μm



Au, Period: 2,4 μm
No bridges, 2 μm holes perpendicular to the lines under an angle of 45°

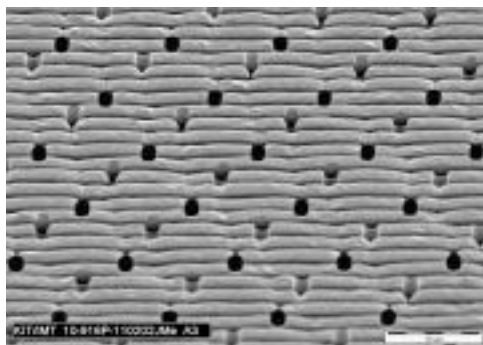
Gratings for Phase contrast imaging / Recent achievements

High absorption structures

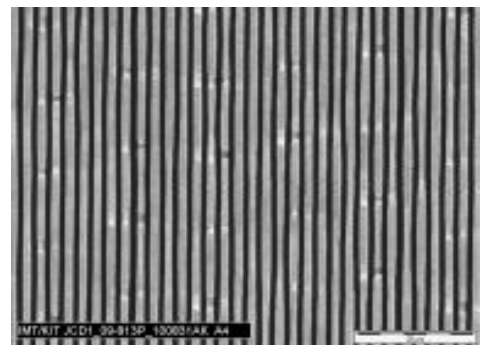


Structures with supporting bars:

With LIGA X-ray lithography we can pattern and electroplate resist structures, for example with a height of 130 μm at a periodicity of 2.4 μm. By using a second tilted exposure to add supporting bars between the lamellae (left), we hope to extend the height-to-width ratio by another factor of 2.

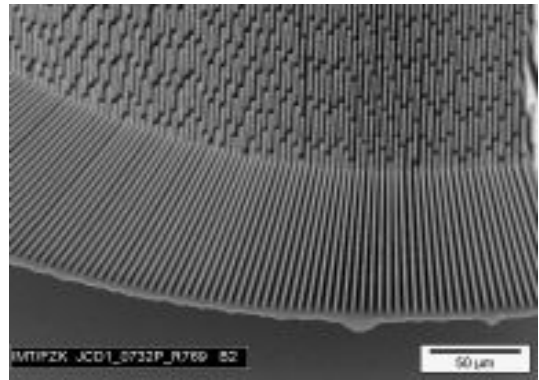


Electroformed grating structures fabricated out of resist templates with supporting bars Au, Period: 2.4 μm, Height: 100 μm

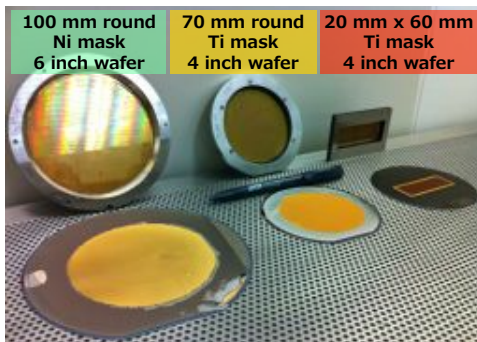


Bent structures

When we pattern gratings on a 100 μm-thin titanium foil, a bending radius as small as 2.5 cm can be achieved. Here a grating is held in place by a pre-bent holder (left). Illustration of bent structures (right).

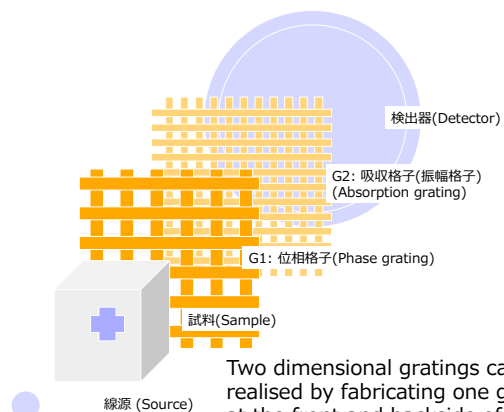


Large area gratings



X-ray lithography requires special masks. Ni foils allowed us to fabricate 100 mm diameter gratings. The first of these are now being evaluated for use in phase contrast imaging.

Two dimensional gratings



Two dimensional gratings can be realised by fabricating one grating each at the front and backside of the substrate.