Inprentus, Inc.
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1 Introduction

Inprentus manufactures master diffraction gratings using *mechanical ruling*. A metal film is deposited on a substrate, and gratings are inscribed in this film, one groove at a time, using a diamond tool. Laser interferometers monitor the tool to ensure that each each groove is positioned correctly. At a pitch of 400 nm, for example, diffracted-wavefront error is less than $\lambda/20$.

Due to the serial writing process, there is no intrinsic constraint on grating size or shape. Multiple-grating masters are supported.

The principal advantage of the mechanical ruling process is the ability to *blaze* gratings for high efficiency. Blazed gratings require particular, low-symmetry groove shapes in order to concentrate diffracted light into a single radiation mode. Since each groove in the metal film is shaped directly by the diamond tool, mechanical ruling is ideal for the production of blazed gratings.

2 Master specification worksheet

Choose a substrate. A layer of Au will be deposited on the substrate, and grating(s) will be inscribed into that layer.

	Substrate description
☐	SiO_2 circular mirror blank (1-inch diameter, 6-mm thickness)
☐	SiO_2 circular mirror blank (2-inch diameter, 12-mm thickness)
☐	SiO_2 square photomask (6-inch edge, 0.25-inch thickness)
☐	Si circular wafer (4-inch diameter)
☐	Si circular wafer (6-inch diameter)
☐	Other (contact Inprentus for details)

Choose a coating. After inscribing grating(s) into the Au film, a conformal capping layer will be desposited.

	Coating description
☐	None
☐	Ta (20-nm thickness, oxidized surface is compatible with standard release chemistry)
☐	Other (contact Inprentus for details)

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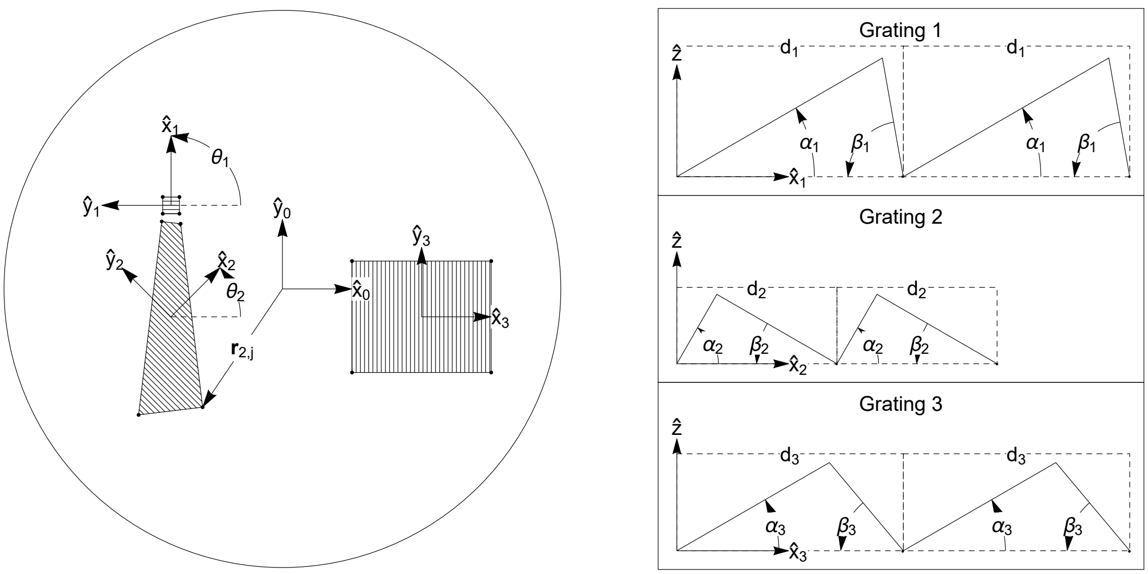

Symbol	Meaning
$\hat{\mathbf{z}}$	Substrate normal
$\hat{\mathbf{x}}_0, \hat{\mathbf{y}}_0$	Substrate-surface basis
$\hat{\mathbf{x}}_i$	Dispersive direction of ith grating
$\hat{\mathbf{y}}_i$	Non-dispersive direction of ith grating
d_i	Period of ith grating
α_i	First groove-facet angle, relative to substrate surface, of ith grating
β_i	Second groove-facet angle, relative to substrate surface, of ith grating
θ_i	Angle between $\hat{\mathbf{x}}_i$ and $\hat{\mathbf{x}}_0$
$\mathbf{r}_{i,j}$	For the ith grating, location of jth vertex, relative to substrate origin

Figure 1: Geometric parameters employed in the specification worksheet. The example gratings shown here are for illustration.

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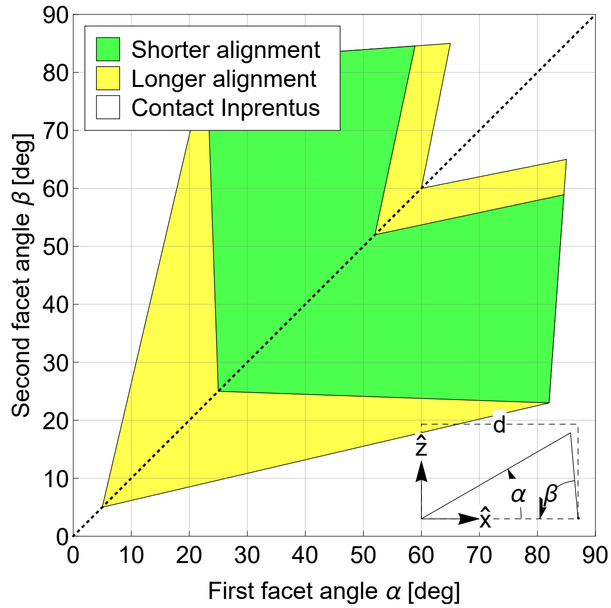

Figure 2: Qualitative difficulty of manufacturing a triangular groove profile with facet angles α and β. Manufacturing time and cost can be reduced by selecting triangular profiles from the green parameter space.

Define the shape of grating 1 in the substrate-surface plane (see Fig. 1). Express vertices in the substrate coordinate system; for example, $x_{1,1} = \mathbf{r}_{1,1} \cdot \hat{\mathbf{x}}_0$.
Non-quadrilaterial shapes are supported; contact Inprentus for specification requirements.

Parameter	Value	
Rotation [deg]	$\theta_1 =$	
Vertex 1 [mm]	$x_{1,1} =$	$y_{1,1} =$
Vertex 2 [mm]	$x_{1,2} =$	$y_{1,2} =$
Vertex 3 [mm]	$x_{1,3} =$	$y_{1,3} =$
Vertex 4 [mm]	$x_{1,4} =$	$y_{1,4} =$

Define the shape of the grooves in grating 1 (see Fig. 1). Configuring a diamond tool to produce a particular groove shape is a non-recurring, but potentially protracted, process. Manufacturing time and cost can be reduced by selecting a triangular profile from the green parameter space shown in Fig. 2.

Parameter	Value
Period [nm]	$d_1 =$
First facet angle [deg]	$\alpha_1 =$
Second facet angle [deg]	$\beta_1 =$

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Additional gratings on this substrate can be defined below. If multiple *independent* gratings are desired—for example, iterations on a single grating design—manufacturing time and cost can be reduced by placing each grating on a separate substrate to parallelize the writing process.

Minimum separation between gratings is 1 μm. Uncertainty in grating rotation, θ, is 10 μrad or 2 arcsec.

Define the shape of grating 2 in the substrate-surface plane (see Fig. 1).

Parameter	Value	
Rotation [deg]	$\theta_2 =$	
Vertex 1 [mm]	$x_{2,1} =$	$y_{2,1} =$
Vertex 2 [mm]	$x_{2,2} =$	$y_{2,2} =$
Vertex 3 [mm]	$x_{2,3} =$	$y_{2,3} =$
Vertex 4 [mm]	$x_{2,4} =$	$y_{2,4} =$

Define the shape of the grooves in grating 2 (see Fig. 1).

Parameter	Value
Period [nm]	$d_2 =$
First facet angle [deg]	$\alpha_2 =$
Second facet angle [deg]	$\beta_2 =$

Define the shape of grating 3 in the substrate-surface plane (see Fig. 1).

Parameter	Value	
Rotation [deg]	$\theta_3 =$	
Vertex 1 [mm]	$x_{3,1} =$	$y_{3,1} =$
Vertex 2 [mm]	$x_{3,2} =$	$y_{3,2} =$
Vertex 3 [mm]	$x_{3,3} =$	$y_{3,3} =$
Vertex 4 [mm]	$x_{3,4} =$	$y_{3,4} =$

Define the shape of the grooves in grating 3 (see Fig. 1).

Parameter	Value
Period [nm]	$d_3 =$
First facet angle [deg]	$\alpha_3 =$
Second facet angle [deg]	$\beta_3 =$