Appendix

Creating Photomask files for use with Laser Cut alignment system

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5.8.2012

Greetings Student, This document will guide you through the steps needed to create a photomask design suitable for cutting with the laser and use with the mask alignment platform. The general steps to a successful photomask are feature design, mask design, and cutting out the masks with the laser. Finally some helpful tips and tricks are included at the end.

Step 1. Feature Design

When designing features, it is important to keep in mind the limitations from print resolution and in the lithography process. In general keep feature sizes above 75µm thick, and keep in mind that corners tend to round off. Also, when a feature must be continuous with a layer above, be sure to keep in mind that a 250µm displacement is common from layer to layer. When you are satisfied with the feature design, group all the layers together to ensure that they remain correctly aligned when transferred to the print document. As a rule of thumb, don't separate feature layers until the last step.

Step 2. Mask design

Once the feature design is complete add the features to the PhotomaskTemplate.ai file. This file has 5 layers;

- TO CUT- The shape the laser will cut to fit the masks to the platform, This layer also includes blue guides which reflect the walls of the alignment platform which places the mask in the correct position relative to the cut. DO NOT alter this layer.
- Total Cut- The "TO CUT" layer copied 4 times. It is this layer that is ultimately sent to the laser for cutting.
- Guides- Layer may be used to center feature designs to the mask
- MaskLayer1 and MaskLayer2- An alignment marker is included in these layers. Markers and circular mask objects are locked to prevent translation, and must be unlocked to be selected.

Copy your features group to "Layer1" and position and duplicate them to your liking. Use the Guides to find exact center and quadrants. When the features are set in the correct spot, you can separate features into Layer1 and Layer2. Do this by ungrouping the features, selecting your layer 2 features, clicking on Layer2, and then right click anywhere on the canvas and select Arrange>Send to Current Layer. Check that you have done this correctly by turning on and off the layer 1 visibility. The next step is to duplicate and position MaskLayer1, MaskLayer2 and TO CUT in to the correct spot (where Total Cut is placed). Do this by selecting MaskLayer1, MaskLayer2, and TO CUT (be sure layer is unlocked). Use the Object>Translate>Move tool, select 4in horizontal and click "copy." There should now be a copy of your mask to the right of the original. Now the newly copied layers should still be selected. Use the Move tool again at -5in, and then again -4in. Lock the TO CUT layer (should be identical to Total Cut). The last step is to delete the MaskLayer1 shapes on the right hand side and the Mask Layer2 on the left hand. Your mask is now ready for printing.

Step 3. Cutting out the masks with the laser

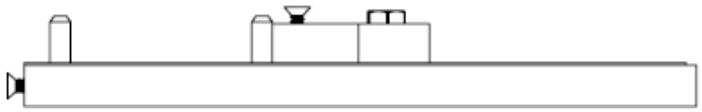
Begin by making sure the laser has the correct focus by attaching the manual focusing widget to the laser, selecting "focus" mode, and using the up and down arrows until the tip of the focusing widget is just touching the base, then select "reset."

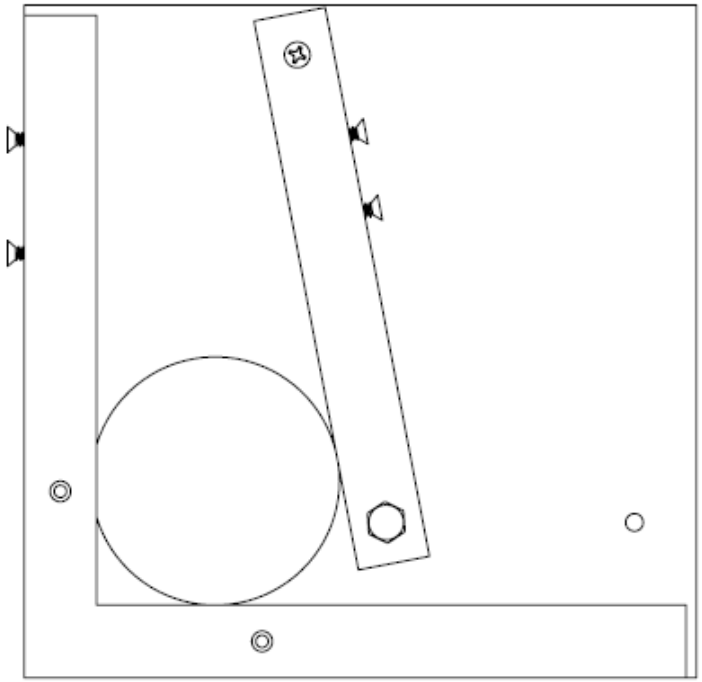
The printed masks you receive will not be on standard 8.5x11” sheets and some adjustments must be made to the “CutTemplate.eps” document so the laser cuts in the correct spot. This is done by running a trial run on paper and comparing the displacement of where the laser cut with the photomask, and adjusting the CutTemplate file. For the paper trials the Laser print settings should be 5% power, 100% speed and max frequency. Also be sure to make sure auto focus is off, vector is checked, and the document size is 9.5x12”. Run the trial cut on paper, measure what adjustments need to be made, adjust the file and save it under a new name to preserve the original. Run another trial on paper to be sure that the cut is in the correct place. When your satisfied cut the masks out on 20% power, 50% speed and full frequency. Photomasks are now ready for use with the alignment platform.

Tips and Tricks in Adobe Illustrator

- Can’t select a layer? Make sure its unlocked.
- The Black arrow selects entire objects, the white arrow selects lines and anchors.
- Hold down Shift to add to selections.
- Use the “o” shaped button on the layers palate to the right of the layer name to select all features associated with that layer. This is a simple way to select multiple layers.
- Locked layers and Invisible layers can’t be selected.
- Use “Smart Guides” (View>Smart Guides) to snap features into place.
- Trouble aligning layer features with one another? Select both features and us the “align to key object” in the dropout menu under the alignment palate. The un-bolded feature will align to the bolded one. Click which feature you want bolded.
- BE ORGANIZED. Name your layers and objects. Use grouping.
- Want to make a “hole” in an object? Select the solid and the hole inside and right click>”make compound path” and voila.

PDF File:





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		FRACTIONAL ±	ENG APPR.		
		ANGULAR: MACH ± BEND ±	MFG APPR.		
		TWO PLACE DECIMAL ±	Q.A.		
		THREE PLACE DECIMAL ±	COMMENTS:		
		INTERPRET GEOMETRIC TOLERANCING PER:			
		MATERIAL			
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

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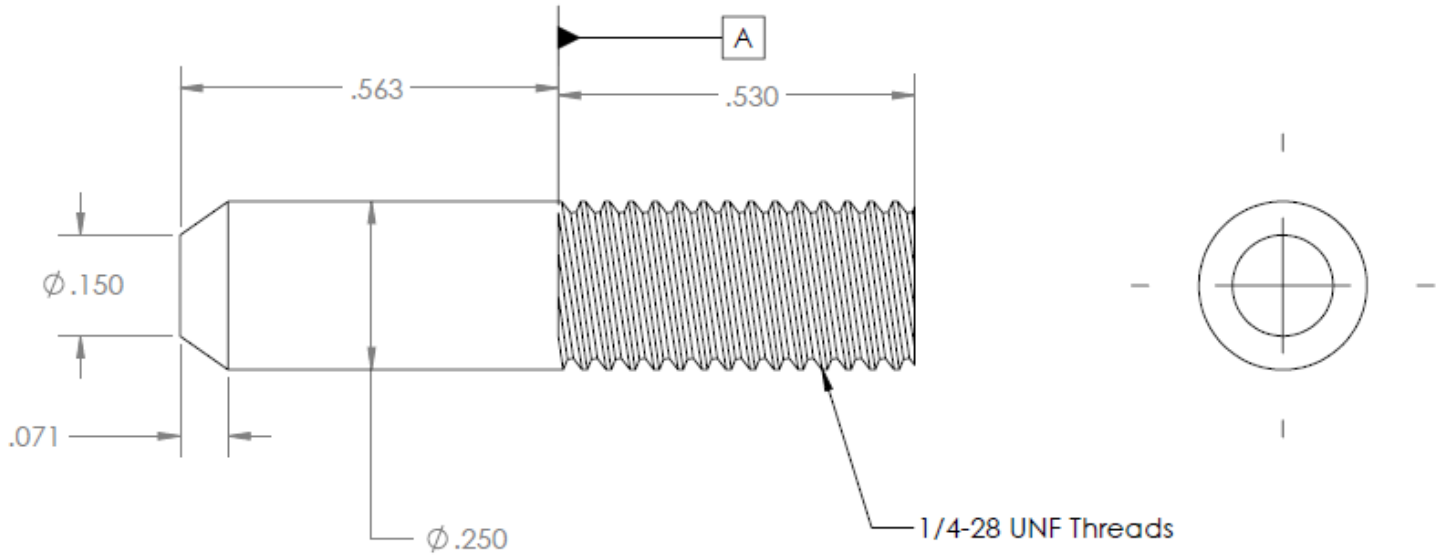
TITLE:
BioMEMS Photomask Aligner (3" Wafer)

SIZE	DWG. NO.	REV
C	BioMEMS Photomask Align	

SCALE: 1:1	WEIGHT:	SHEET 1 OF 1

Taken from 1/4-28 Hex Cap Screw

Cut off hex head and chamfer as shown:
Shorten threads as shown here:



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			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL Stainless Steel	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

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TITLE:

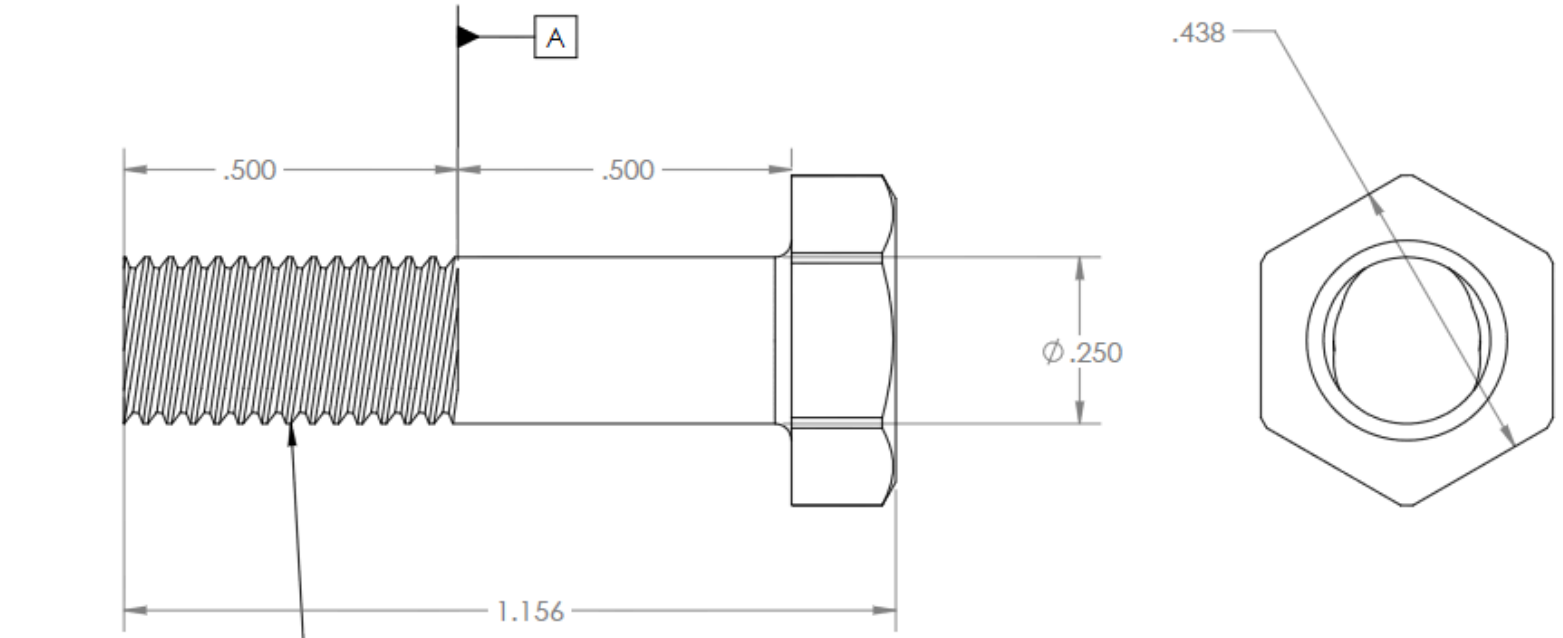
Alignment Pin

SIZE	DWG. NO.	REV
A	Alignment Bolt	
SCALE: 2:1	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1

Taken from 1/4-28 UNF x 1 1/4 Hex Cap Screw

Shorten threads as shown here



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			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL Stainless Steel	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

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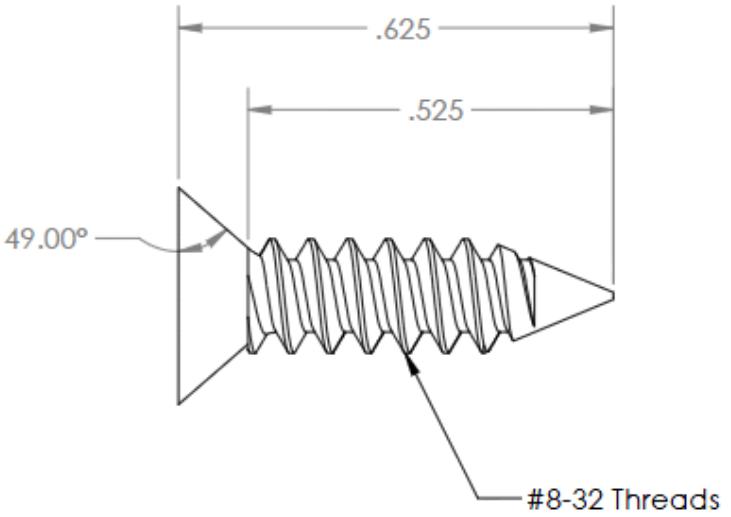
TITLE:

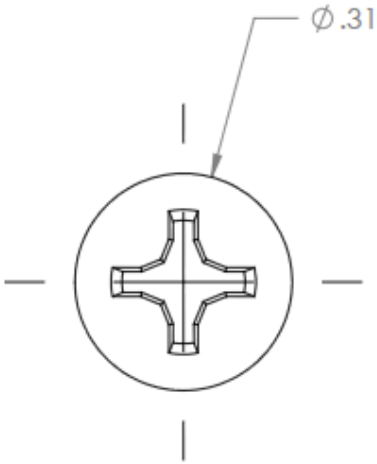
Lock Bar Pivot Bolt

SIZE	DWG. NO.	REV
A	Pivot Bolt	

SCALE: 2:1 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1





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			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL Stainless Steel	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

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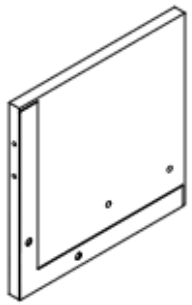
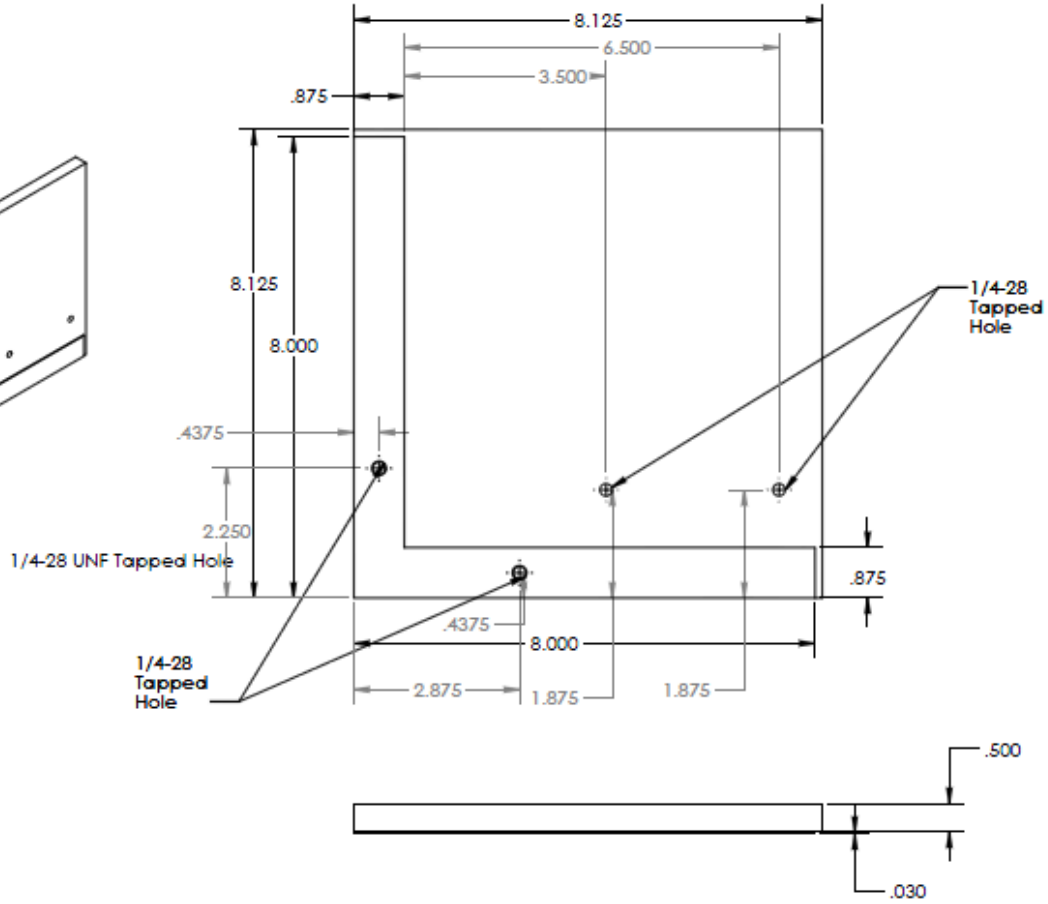
TITLE:

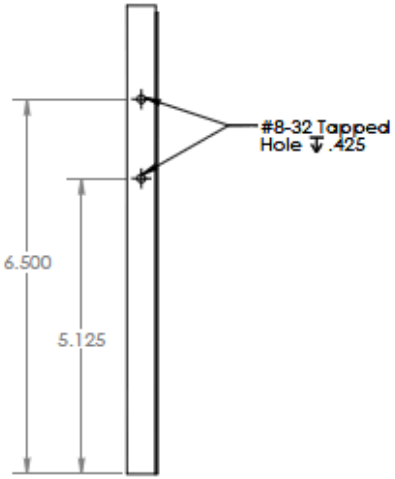
#8-32 x 5/8 Flat Head Phillips

SIZE	DWG. NO.	REV
	Aension Screws	
SCALE: 4:1	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1







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			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL Acrylic/Delrin	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

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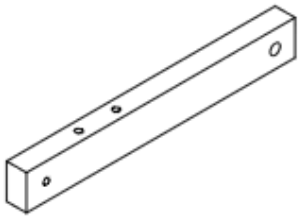
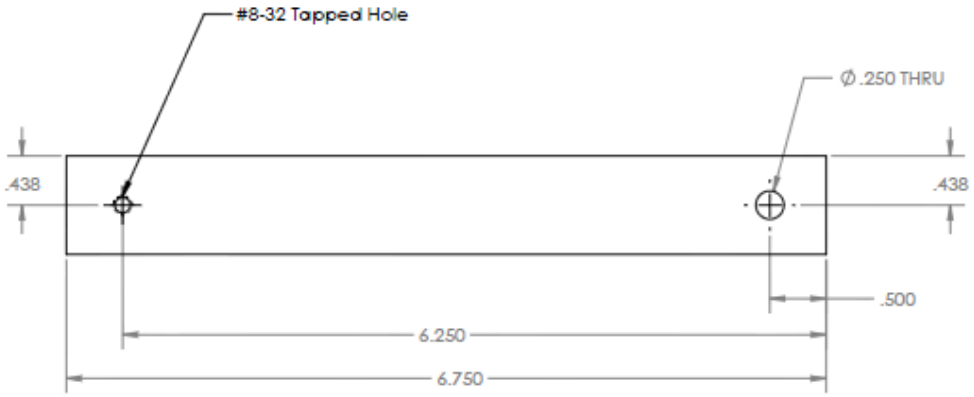
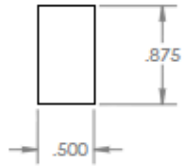
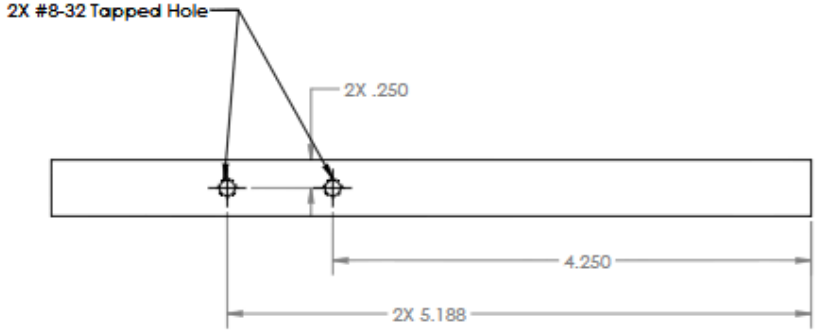
TITLE:
Acrylic Base with Delrin Adhesive Film

SIZE	DWG. NO.	REV
B	Delrin on Acrylic	
SCALE: 1:2	WEIGHT:	SHEET 1 OF 1









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			CHECKED		
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			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL Acrylic	COMMENTS:		
		FINISH			
NEXT ASSY	USED ON				
APPLICATION		DO NOT SCALE DRAWING			

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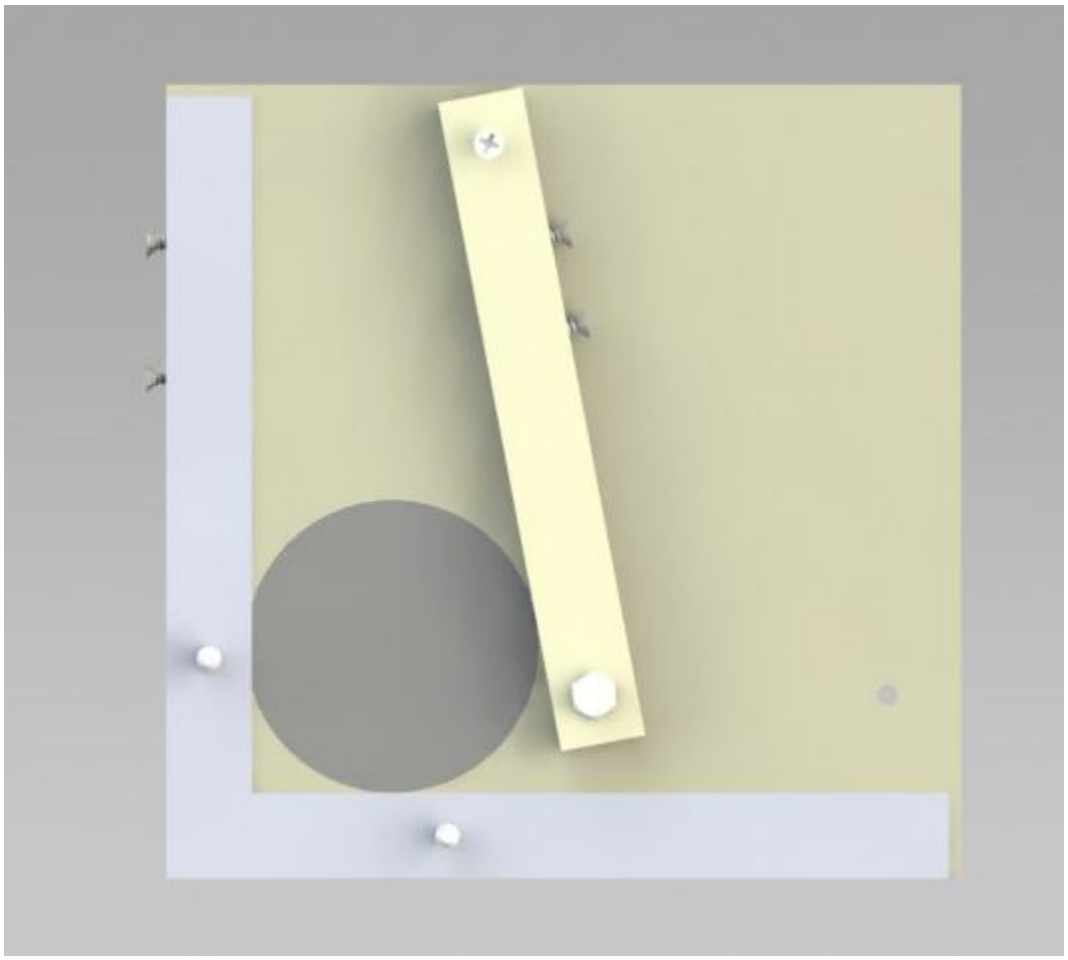
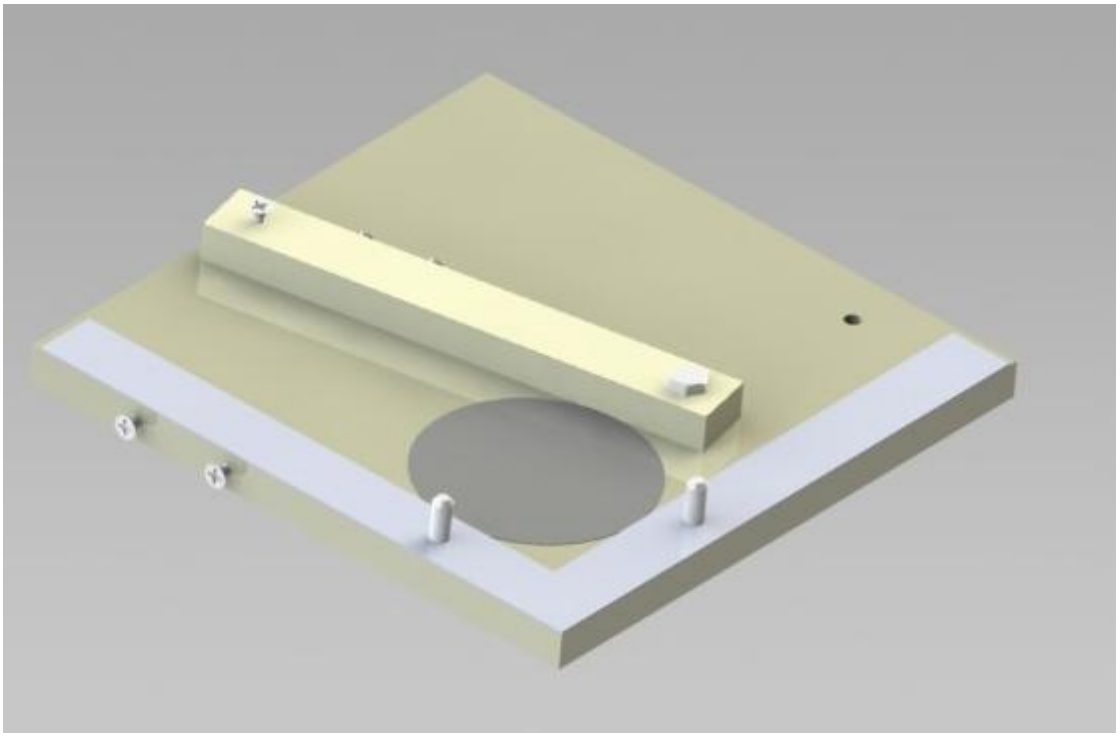
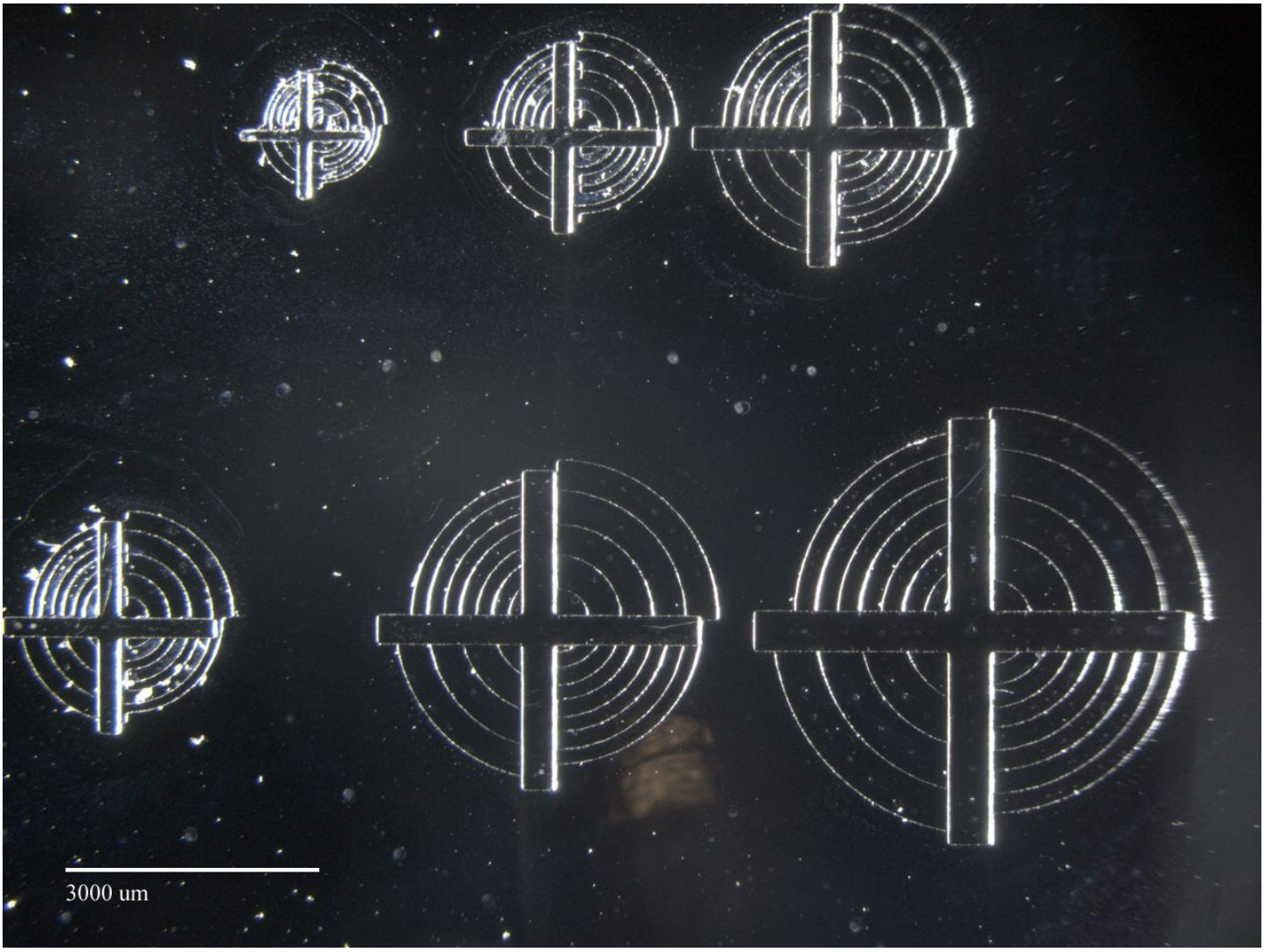
TITLE:
Wafer Lock Bar

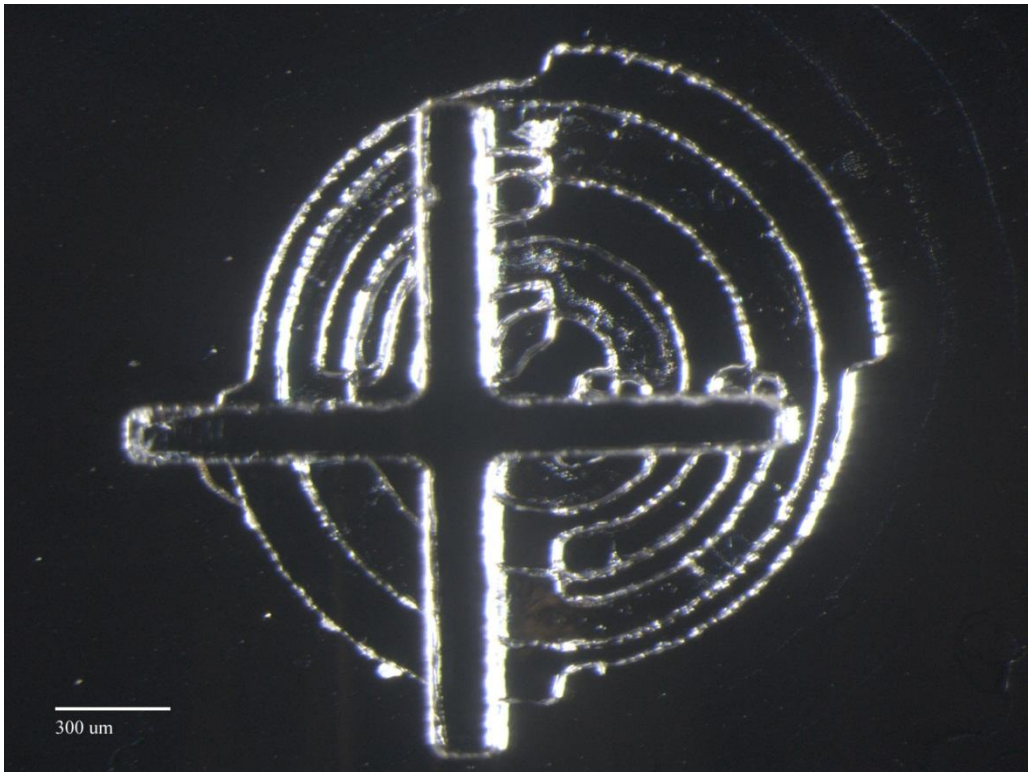
SIZE	DWG. NO.	REV
B	Lock Bar	
SCALE: 1:1	WEIGHT:	SHEET 1 OF 1



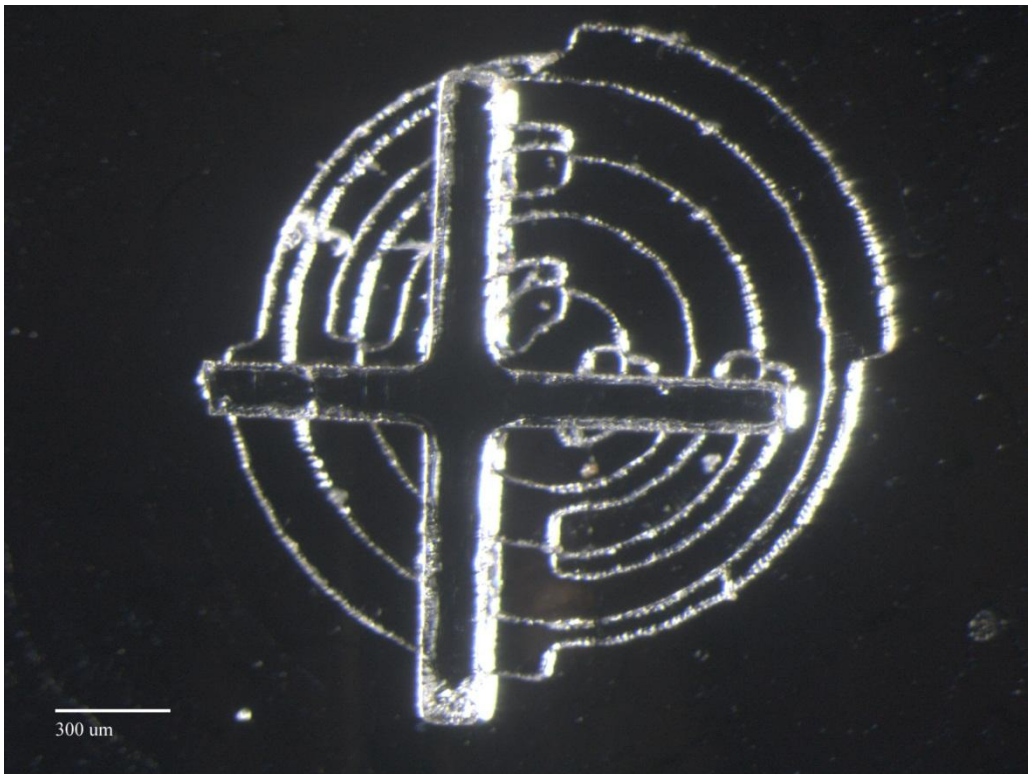




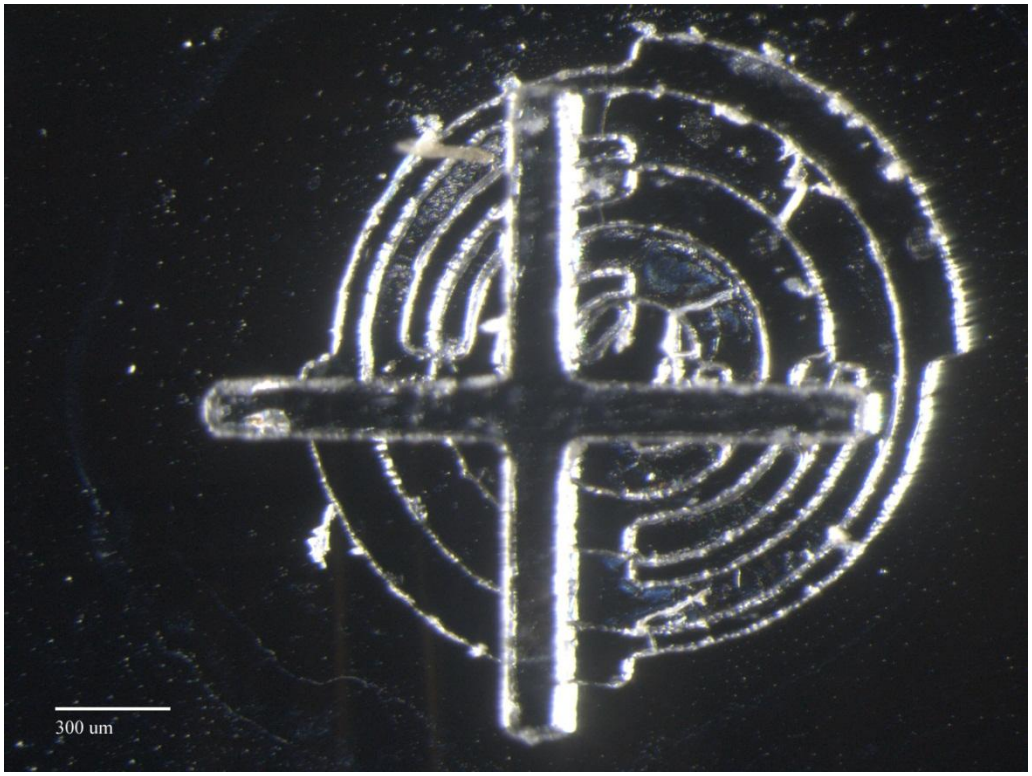
One of the Target/Crosshair samples (middle). 5 of these were made at different locations on a silicon wafer to measure accuracy of the designed photomask aligner.



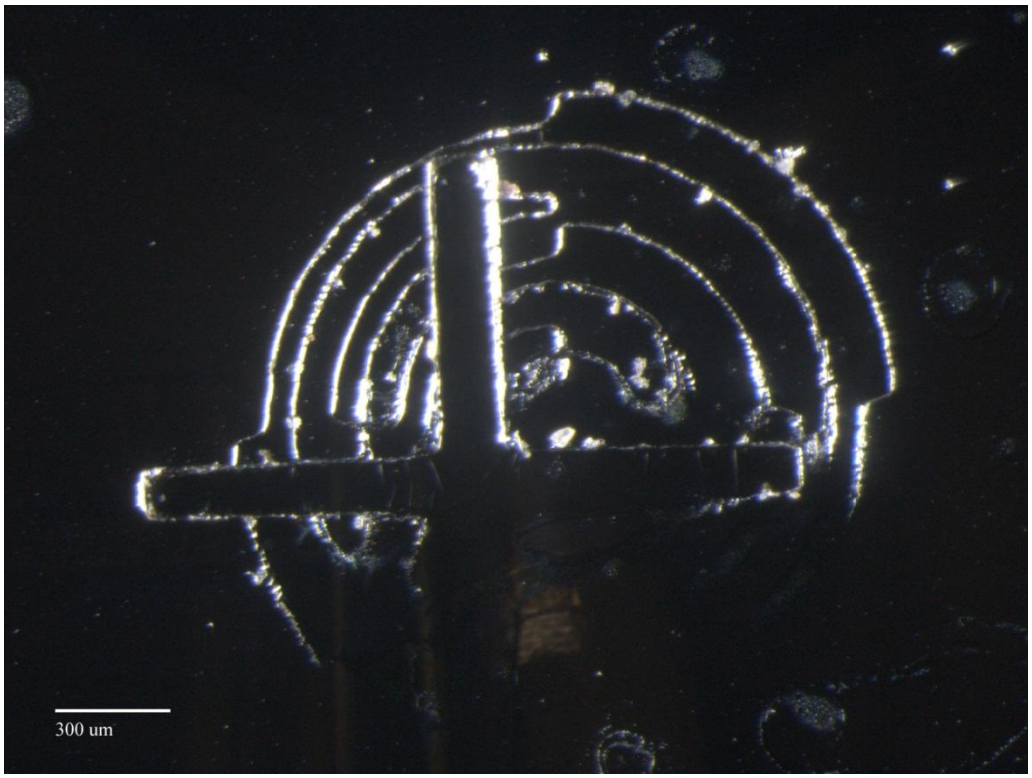
Bottom Left Target Image- Accuracy is 233.4 um



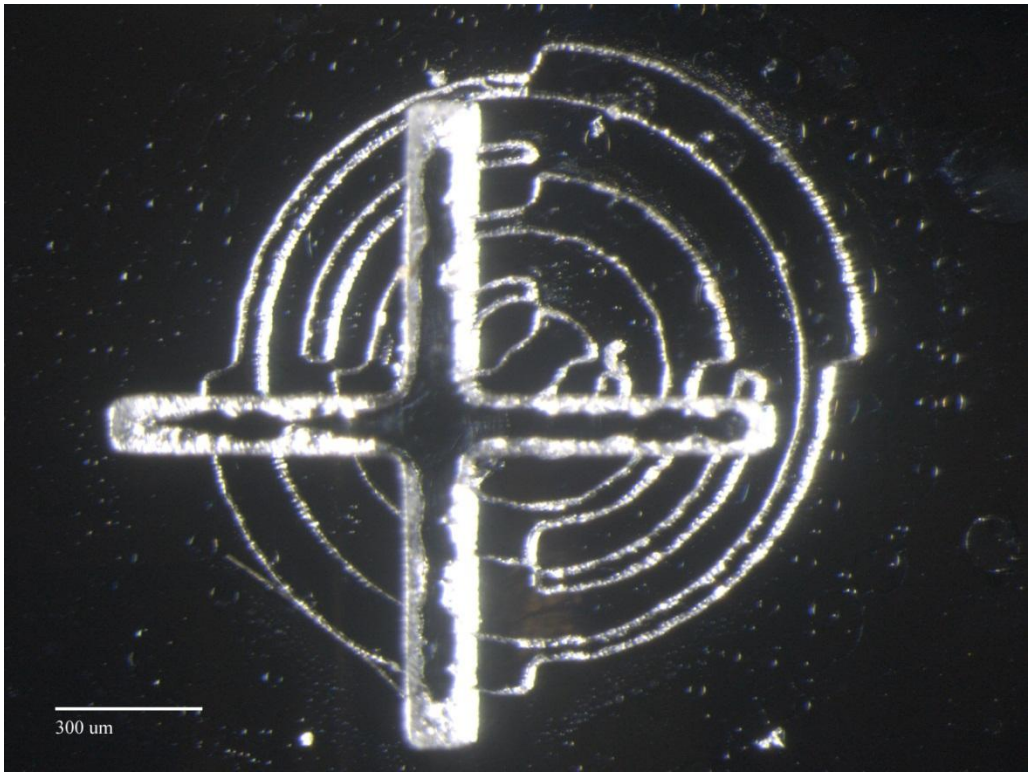
Bottom Right Target Image- Accuracy is 235.32 um



Middle Image Smallest- Accuracy is 224.5 um



Top Left Smallest-Accuracy is 249.7 um



Top Right Smallest-Accuracy is 247.9 um

Using all 5 of the smallest target/crosshair accuracy measurements, an average accuracy of 238.164 um ± 10.55175 um was found.