

Photomask Drawing Design Rules

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Photomasks can be created using standard CAD (computer-aided design) software. If you don't have previous experience with CAD software I recommend starting with DraftSight (<https://www.3ds.com/products-services/draftsight-cad-software/free-download/>) software, a free software package (activation with a valid email address is required). You can also use multipurpose CAD software AutoCAD, that is free for students or educators with the Autodesk education license <https://www.autodesk.com/education/free-software/autocad> (activation with valid university email address), or if you are not student or educator you can get a free trial.

Once you have created and saved your mask in a suitable file format you can send the files to a company specialized in photomask printing on transparency film. If you are using CAD software for mask drawing, common file formats are DXF and DWG. Typical resolution for photomask on transparency film is in the range between 5,000 and 25,000 dpi (dots per inch) corresponding to feature resolution between 50 and 10 μm . Always ask for a proof copy of your mask layout before ordering mask from the company. The proof copy is usually PDF file showing your mask layout and indicating filled areas on the mask.

If you require higher resolution (less than 10 μm) you may need to consider a chrome mask on glass fabricated using laser or electron-beam etching. This mask is suitable for resolutions down to 1 μm or even 0.1 μm ; however it is much more expensive than a photomask on transparency film.

If you require a chrome mask on glass please contact Dario at bogojevicd@smh.ca

The following are basic design rules you should follow when preparing your photomask layout regardless of CAD software you use.

1. Use zero-width closed polylines

Draw filled areas using zero-width closed polylines. A microfluidic channel needs to be an enclosed polyline outline, rather than a single line with finite width. Note that your closed polylines must enclose a non-zero area to be printed.

2. Don't use hatching

Don't use hatching to indicate filled areas on the mask, instead draw the area's contour using zero-width closed polylines. The mask printer doesn't recognize hatching to indicate filled areas on the mask. This information needs to be given to the mask printer. For example, in your order, you might specify "black features on a clear mask" or "clear features on a black mask" and these instructions would produce, from the same drawing file, exactly inverted output. The

general rule, if you specify “black features on a clear mask,” is that the page borders will be clear and any closed feature (a circle, closed polyline, etc.) will be completely filled black. Any closed feature completely within that black feature will be clear, and any closed feature completely within that clear shape will be black, and so on, flipping between black and clear for each fully enclosed feature. The example below shows three nested squares on the left in the CAD drawing, and the two possible polarity outputs [1].

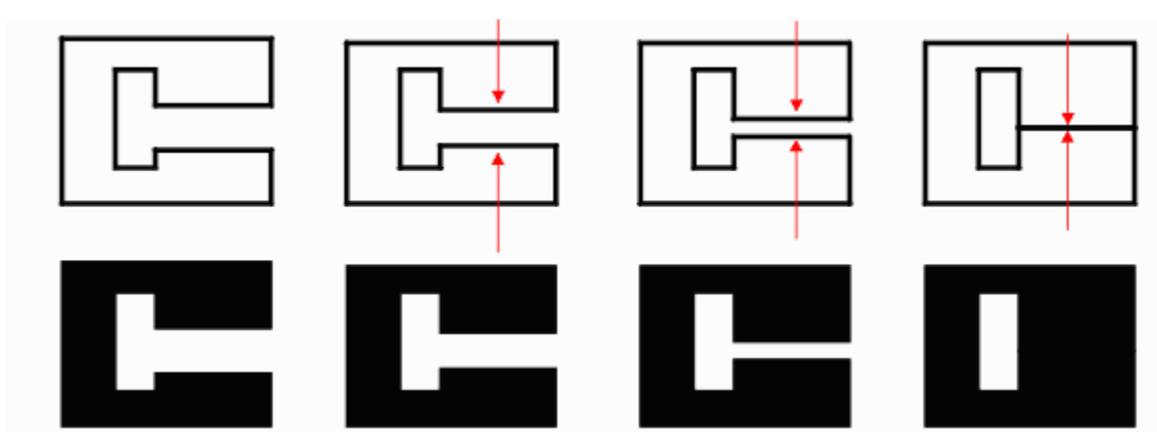


3. Avoid drawing polylines with more than 200 vertices

Vertices refer to each angular point of a polygon, polyhedron, or other figure.

4. No self-intersection

A polyline may not self-intersect. If it does, the result is unpredictable. A polyline may, however, touch itself. This is called a re-entrant boundary, and it can be used to draw filled areas containing holes, as in the figure below (drawing at the right end). Make sure your destination CAD system supports re-entrant boundaries before using them [2].



References

[1] Photomask Drawing using DraftSight; Prof. Dirk Albrecht, WPI Biomedical Engineering BME3601: Microfluidics Laboratory p. 2, 2014

[2] Design Rules for Drawing Masks using AutoCAD, Artwork Conversion Software, Inc