

Printing Masks on Transparency Film at Princeton University

The Princeton University Office of Printing and Mailing in Forrestal can print mask designs on transparency film using commercial image setters (2540 dpi). Consider printing your mask if your design has a minimum feature size no smaller than around 50 μm and you can tolerate a degree of roughness in line shape. Printing a mask is after all considerably cheaper than buying a commercially made chrome mask. A number of groups in the physics and engineering departments at Princeton have published work that relies in part on such low resolution printed masks.

1. Create design using a standard CAD program (like *L-Edit Pro* or *AutoCAD LT*).

It is strongly recommended that you maintain a minimum feature size of around 50 μm . It is possible that features down to 20 μm will be resolved, but this will depend upon the exact geometry of the feature in question. Note that sharp edges in your mask design will be rounded -- for example, rectangular features that are around 50x50 μm in size will be printed as disks. Also, printed masks are not recommended for complicated multilayer designs, due to the difficulty of registering the printed designs.

Lastly, the printing service can in fact reverse the process designs you submit (i.e. print white as black, black as white). Keep this in mind when drawing your design. (It is of course also convenient if you wish to switch to a negative resist, without redrawing the design.)

2. If using L-Edit, export your design to a GDS file. To do this, go to the "File" menu and choose "Export Mask Data" and then "GDSII". If using AutoCAD, you may convert the file directly into postscript. Go to "File" and "Plot". A printing screen will appear. Under "Plotter Configuration" choose "Output Postscript Level 2 (or 1)". Also choose "File Name" and "Location". Another option is that you save the file as DXF and use different software (*LinkCAD*) to convert it to postscript.
3. File conversion. Open the shortcut to *LinkCAD* on the desktop. *LinkCAD* will automatically take you through several menus, most of which are self-explanatory. However, it is important to remember the following:

In the window titled "File Structure", you will see on the LHS a layout of the file's cell structure, and on the RHS a list of the different layers contained in the file. The name of each layer is given and also the layer's color is indicated in a box next to the layer name. Click on a box to change its color. I would change the color of each box to black, as you want to print features with the highest optical density.

In the window titled "Post-Script Export Options", you can adjust a number of options regarding the paper format, the layer layout and the scaling. Under the scaling heading on this window, select the "True Scale" option (this will ensure the original scaling of your L-Edit file is retained).

4. Check postscript file using *Ghostview*. I would print the design and ensure that it is to scale.
5. Send the postscript design to the Princeton Printing service. There are two ways:
 - a) Send your order as an email attachment (the email address is printing@princeton.edu).
 - b) You can follow the directions online at the printing and mailing site for submitting your file electronically (the printing office website is www.princeton.edu/~oitprint/). I have had more luck with a).

Make sure that you inform the printing office by email or phone (8-3493) once you have submitted your order. In the email, it is also important to inform the office (1) that you want the order printed on a transparency film with 2540 dpi resolution, (2) whether you want a positive or negative (reversal) print, (3) that the emulsion should be down, and (4) how many copies you want. Lastly, (5) give a valid account number.

It usually takes half a day for the office to finish your order. You can pick up the order in person (although be aware that the printing office is located in the Forrestal Campus, which is out on Route 1) or have the order delivered to your campus address.

You may also use an outside vendor to print the mask on transparency. Infinite Graphics Incorporated, www.igi.com, is recommended.

6. PRISM requires users to transfer their transparency designs to a chrome mask. This is quite simple and requires only that you purchase a chrome mask (usually obtained prespun with photoresist) and learn how to use the MA6 mask aligner at PRISM. To transfer a design from transparency film to a chrome mask using the MA6, lay the printed transparency on the blank resist-covered chrome mask, making sure that the printed side (i.e. the “dull” side of the transparency) faces down against the mask (with the shiny back of the transparency facing upwards). Then place a clear mask (i.e. a mask with chrome etched away) in the mask holder. The transparency film will then be pressed flat against the clear glass mask during the exposure, ensuring that the design is transferred without too much distortion.

Photoresist/Cr-coated glass plates for mask making can be purchased from:

Nanofilm
2641 Townsgate Road
Westlake Village, CA 91361
(805) 496-5031
<http://www.nanofilm.com>