Mold Machining and Preparation

Materials and Tools:

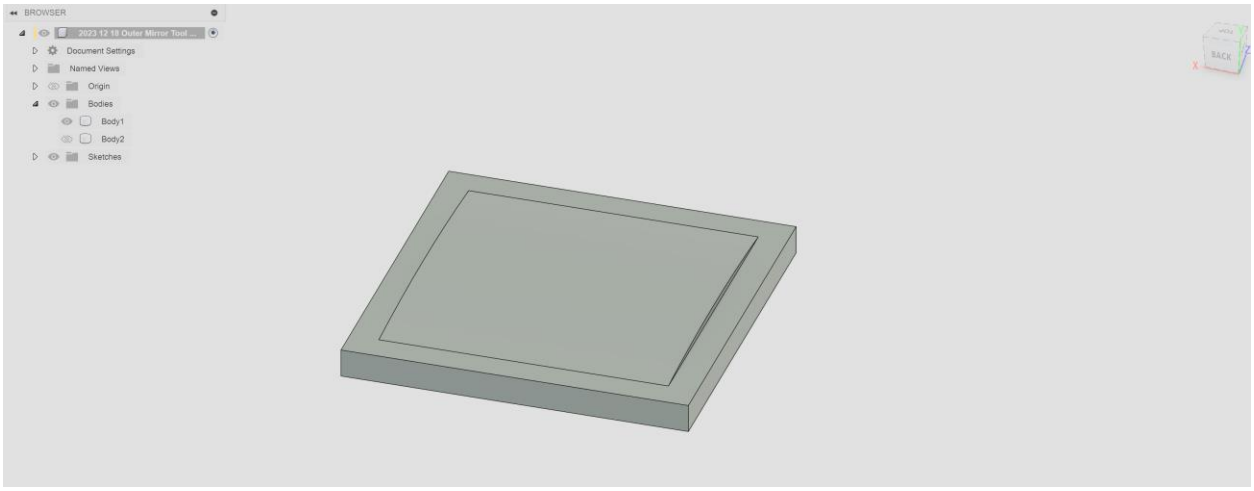
- Plastic or similar CNC-able material, for this SOP, in 120mm x 120mm sections
- CNC Router, Gantry, or other milling machine
    - A square flat end mill for roughing and flat faces (.250in dia)
    - Ballnose endmill for mirror surface (.250in dia)
    - CAM Software (Fusion360)
- Measuring tools (measuring tape, calipers)

Steps to Complete Job:

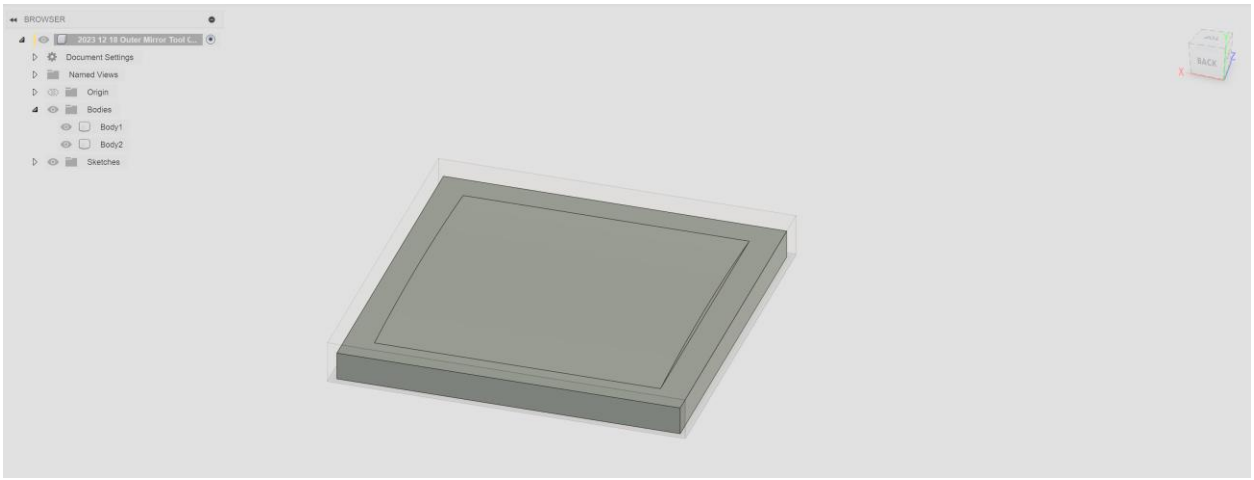
Section 1: Cam preparation (Fusion360)

CAM will be done in Fusion360, as the Carbide CAM software is severely limited when it comes to performing 3D CAM.

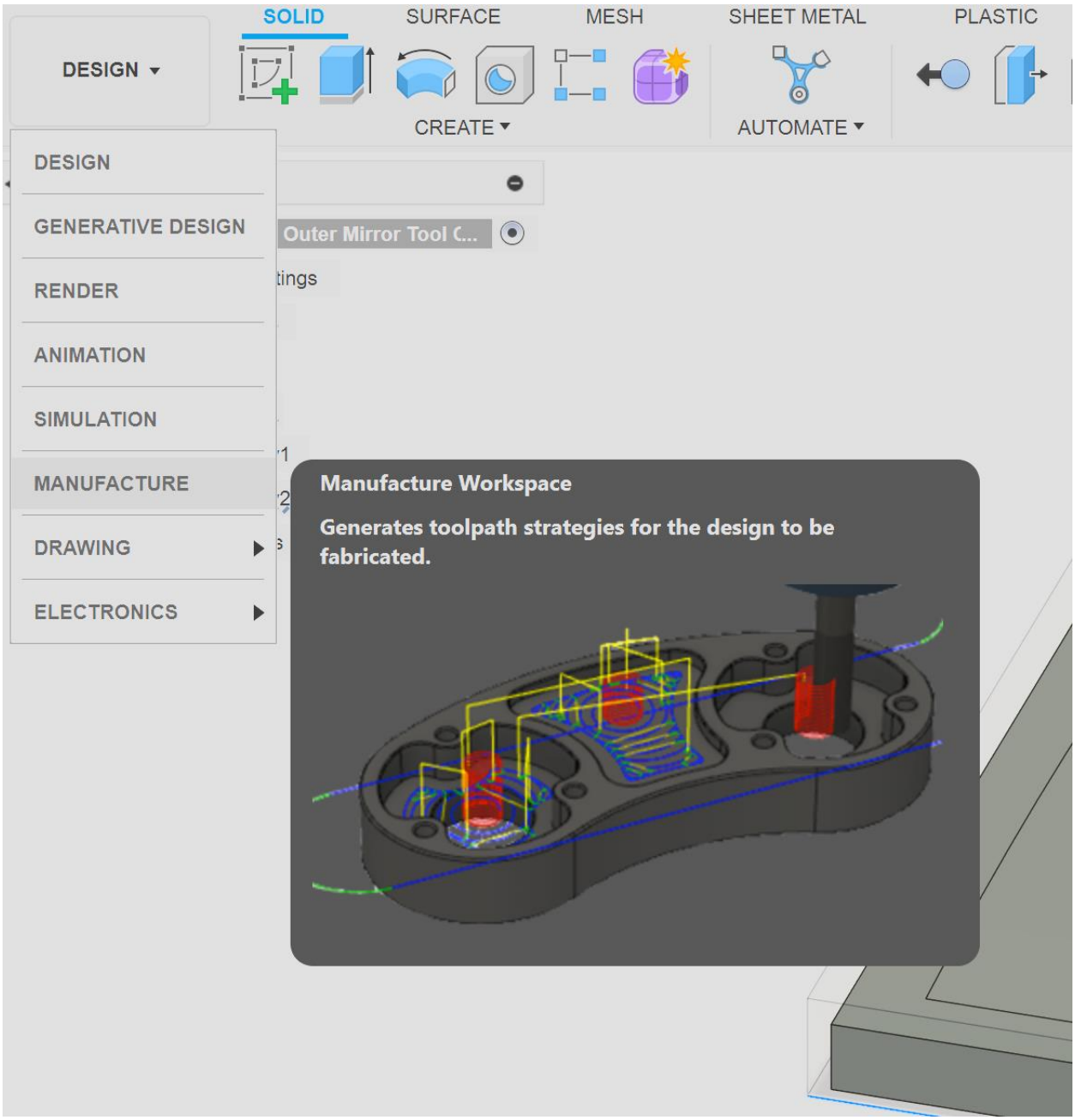
1. Open your mold model in Fusion360. It should consist of a base, and a curved surface for the mirror



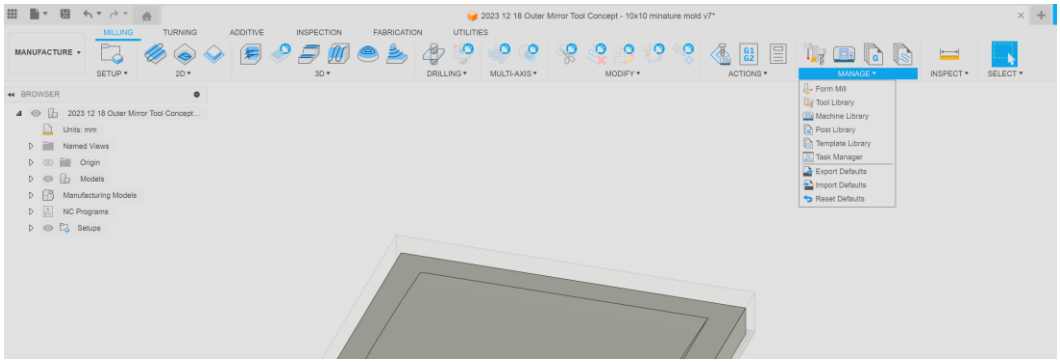
2. Using a sketch and an extrusion, create a stock body that is 125mmx125mmx[as tall as your stock, taller than the model].(it is bigger than the model for tolerance purposes, to ensure that all the edges are appropriately trimmed. If your stock is precisely cut, make your stock exact dimensions] For demonstration, it is opaque in this screenshot



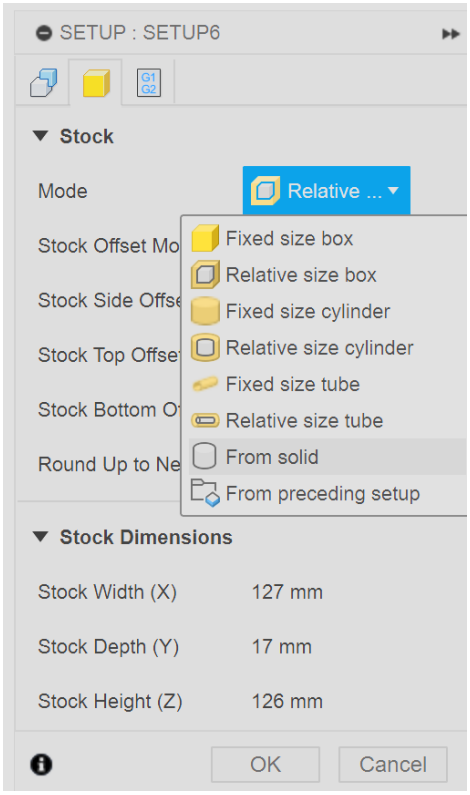
3. Enter the manufacturing tab



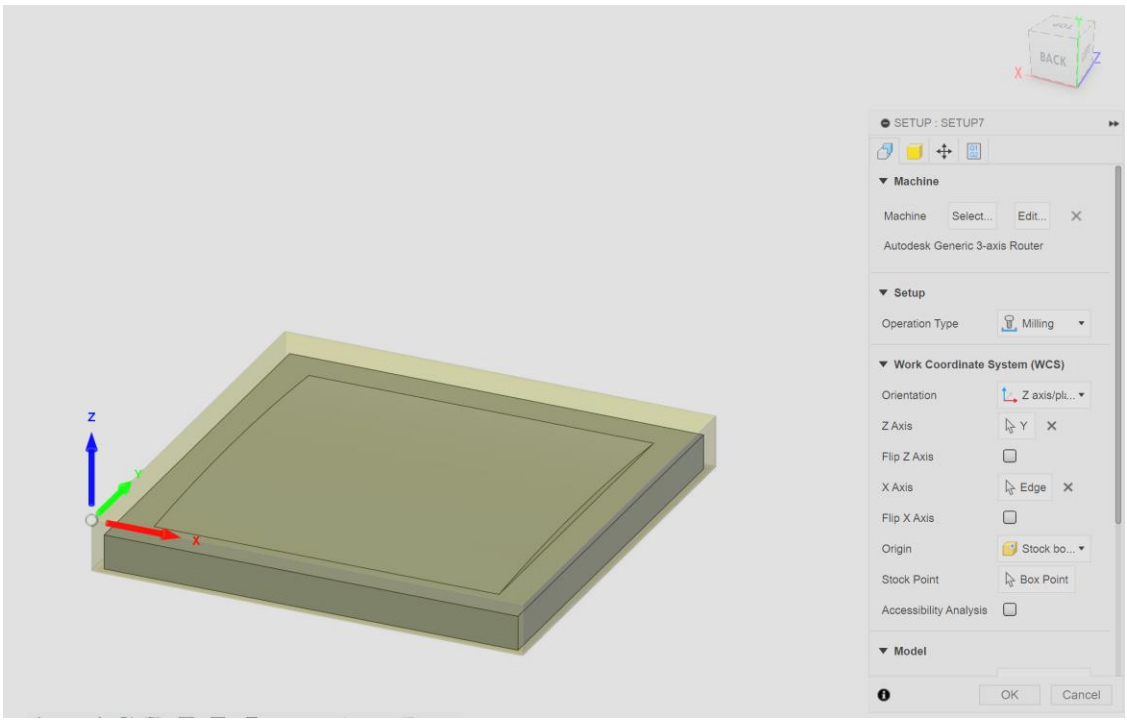
4. If you are using the Carbide in 570:
    a. Go to Manage-> Post Library

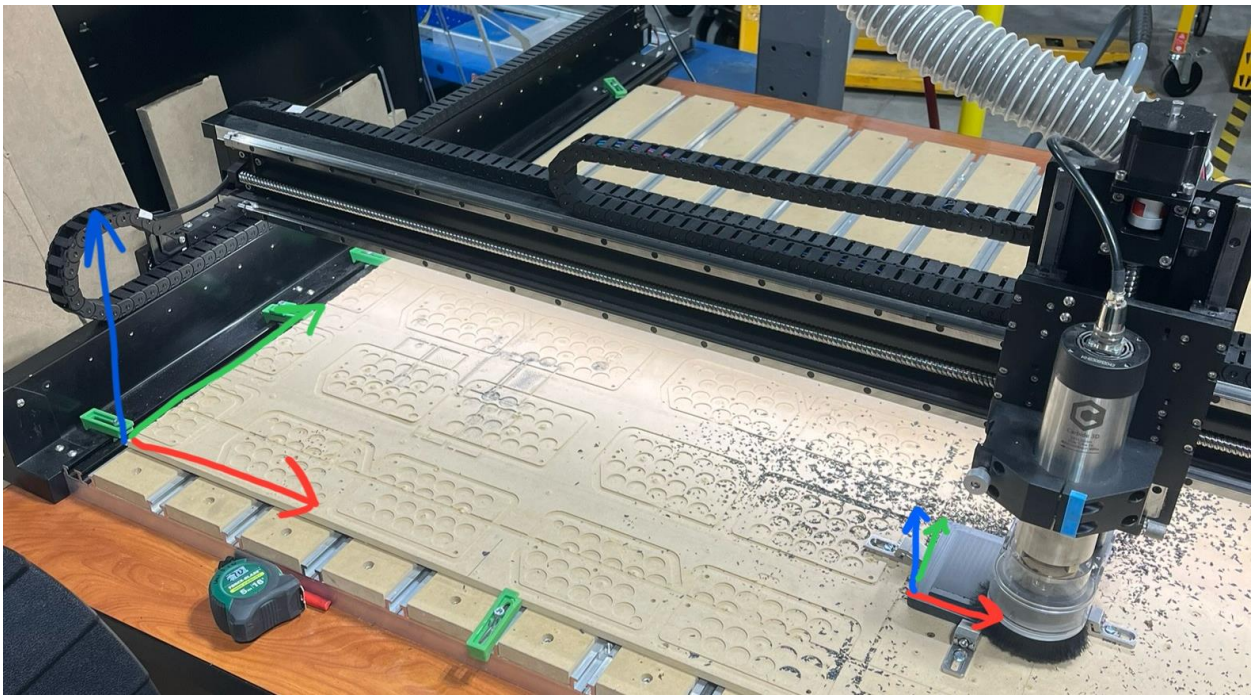


b. Top Left of your screen, create a new setup
c. Go to stock, select “from Solid”, and select the stock you made in the previous steps



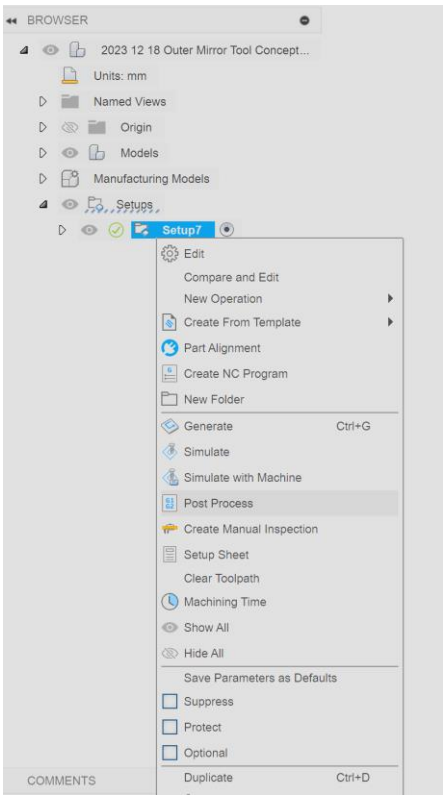
d. Select the Orientation, Z axis, X axis ,and stock point such that it looks like this. Take care to orient the WCS such that the Z is upwards, and the X and Y run along the model. This will define the back left corner as our zero RELATIVE to the WCS of the machine you are using. The positive X, Y, and Z will be the same as that of the machine. You may select another corner for your WCS, however the axes must point in the same direction as your machine.



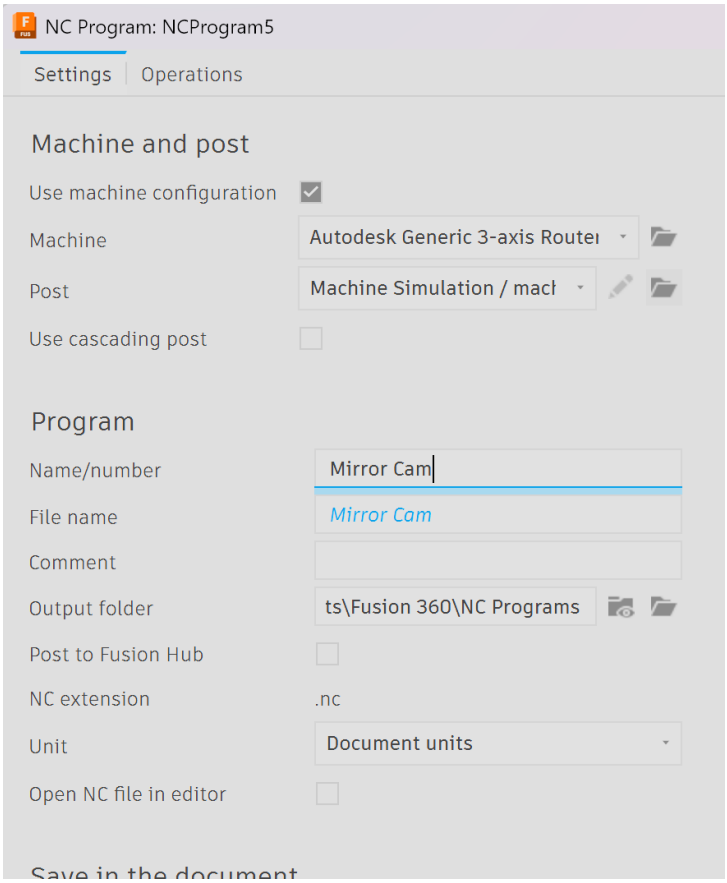


e. Scroll down and select your model as your working body.
f. Click OK
g. Right Click on your setup, and select “Post Process”

h.

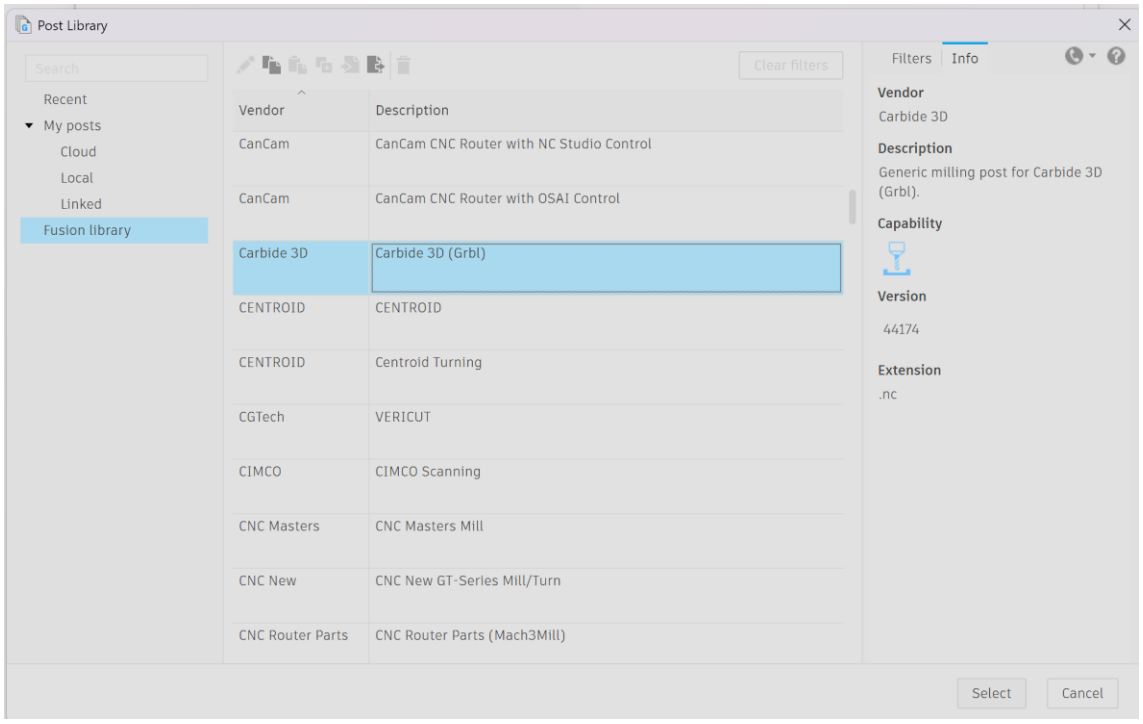


i. Select the folder Icon next to the “Post” Drop Down item

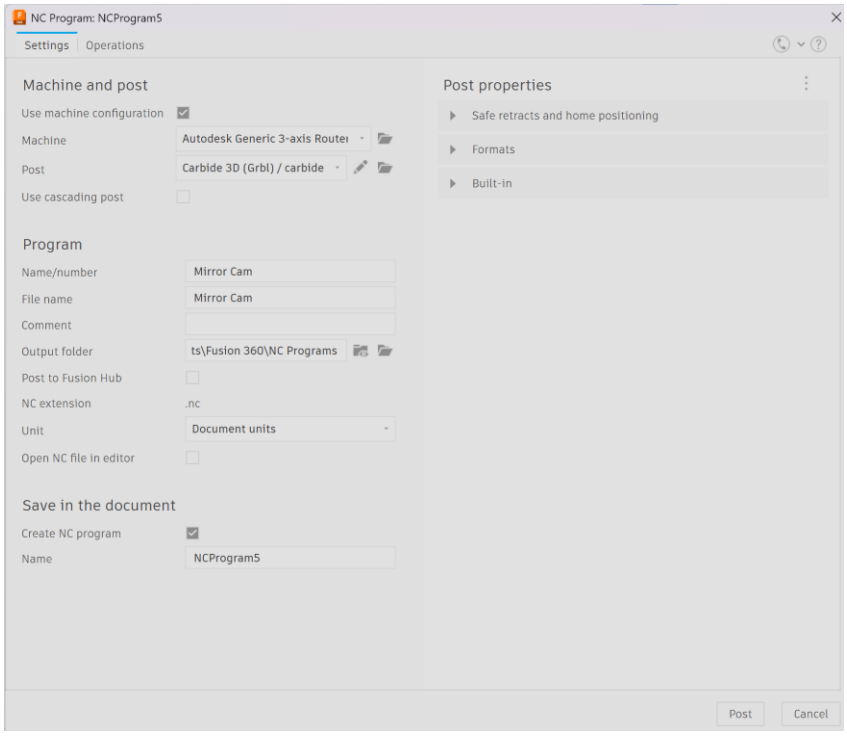


j. Save in the document

k. In the Fusion Library, scroll down, select Carbide 3D, and click select

l. 

m. This is what the NCProgram should look like

n. 

o. Click on Post. An error message saying that there are no operations, this is normal assuming you have not made any CAM yet.

p. It is now up to the

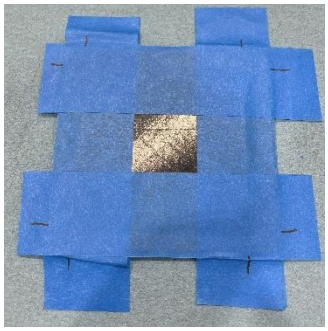
q.

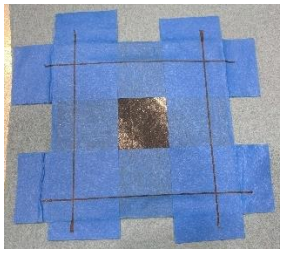
Laminate and mirror Glueup Proccess

Materials:

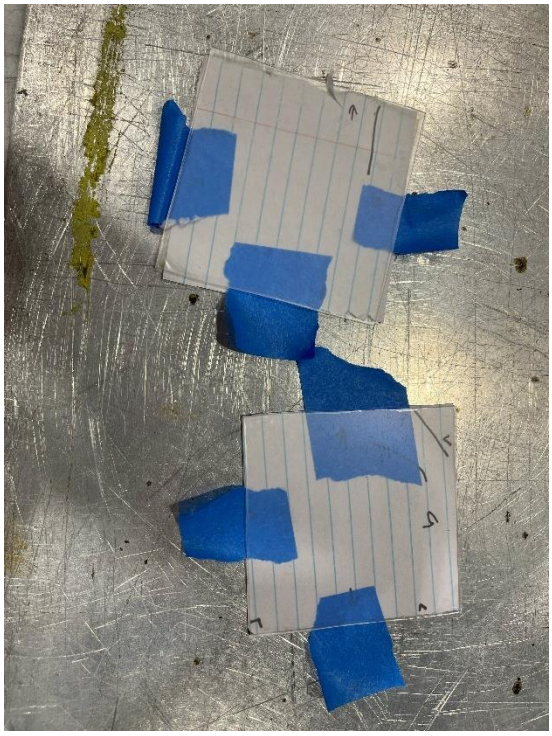
- Process Materials:
    - Cured, unproccessed Bent Laminate
    - Bent Laminate Mold
    - Blue Masking Tape
    - PreCut USPS Lexan Sheets
    - Mixing cup
    - Two small Coffee stirers
    - Yellow Release (Kapton)
    - PT2712 and B2
    - Isopropyl alcohol
    - Shop towels
- Vacuum Bagging material
    - Aluminum Plate
    - Yellow Release (Kapton)
    - Release Blue Tape
    - Vacuum Bag
    - Yellow Vacuum Tape

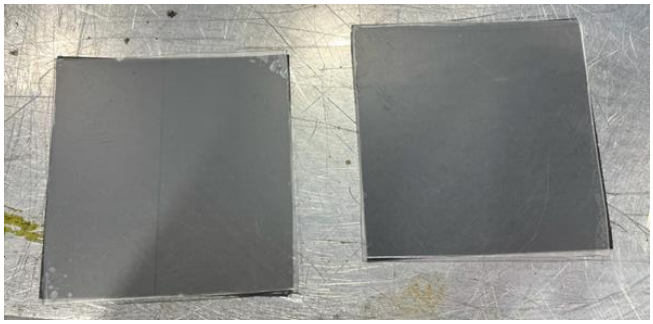
Steps to complete job:

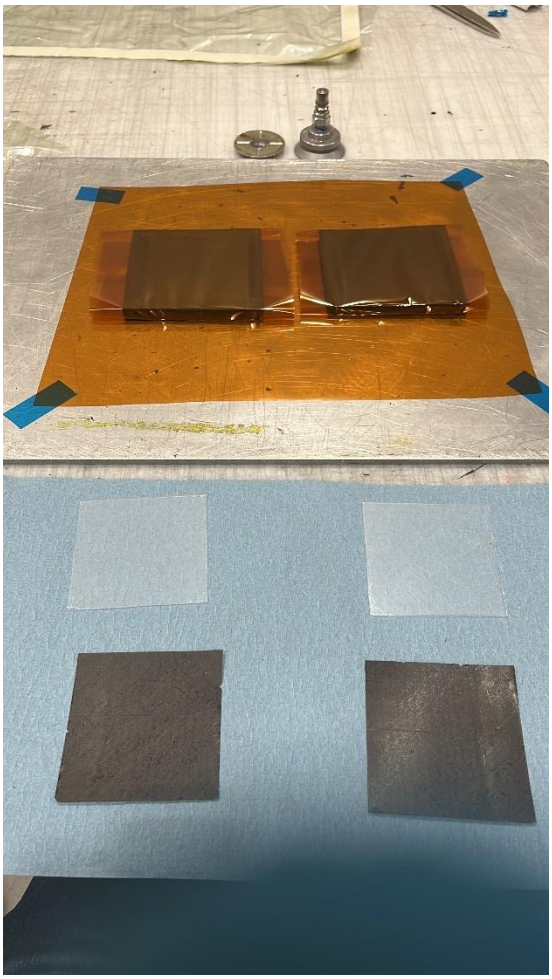
1. The first step is to trim down the bent laminate to the section we need. You will use the orange table saw to trim down the laminate
    a. Start by applying wide Blue Masking tape to each of the edges of the laminate, on one side. Apply it such that the middle of the tape lays slightly inside of the cut line on the laminate
    b. On the side without tape, mark out the far edges of the cut lines on the tape. With a light, copy these cut lines to the top of the masking tape for cutting reference.
    c. 

d. Apply tape similarly to the rear of the piece. Extend the sharpie markings. The sharpie markings should replicate the cut lines clearly. This will be helpful for cutting
e. 
f. On the table saw, line up the laser aligner(or the blade) to the inside of each sharpie line, and cut carefully. You want to cut just enough to ensure that there is no lip, but not too much.

2. Douse the masking tape in IPA. It should soak fully through the masking tape. The masking tape should remove from the carbon extremely easily, with the edges peeling up on their own
   a. 
3. Repeat steps 1-2 as necessary. Allow the laminate to dry.
4. Lay a paper on the laminate, and mark out the corners. Avoid excessively bending the laminate. Cut out the paper with scissors to a rectangle matching the “flattened sheet”.

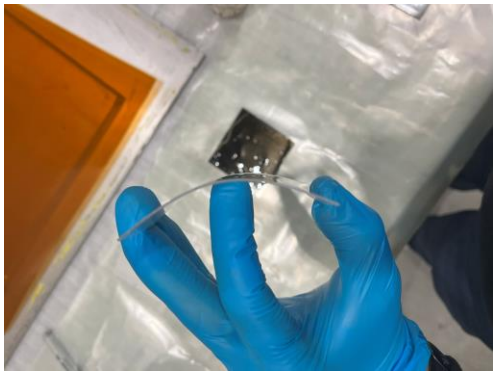
a. 

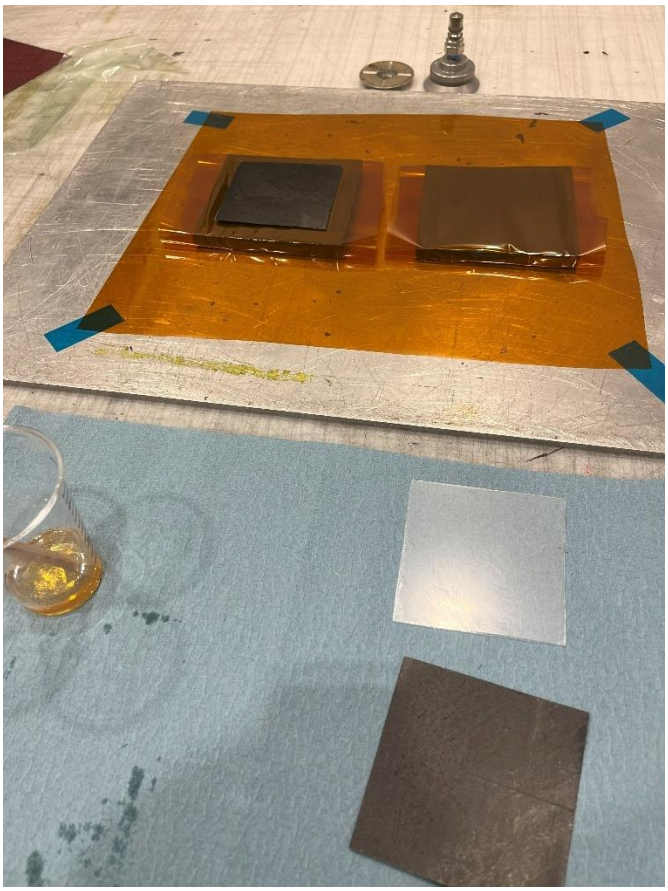
5. You use this paper to cut out a Lexan mate to the laminate. Lay it down on the lexan, and using a blade, mark and cut out the lexan. Ensure protective film remains attached on both sides. Keep the Lexan as close as possible to the size of the paper, or slightly smaller.
    a. After cutting, test align the laminate and Lexan. They should be nearly identical in size.
    b. 
6. Prepare your vacuum setup
    a. Tape down a sheet of Yellow release onto your alumium plate.
    b. Tighly wrap sheets of yellow release onto your molds to avoid wrinkles. Use Blue Tape as needed to hold
    c. Prepare a third sheet of Yellow Release about as large as your bottom sheet
    d. Prepare a vacuum bag

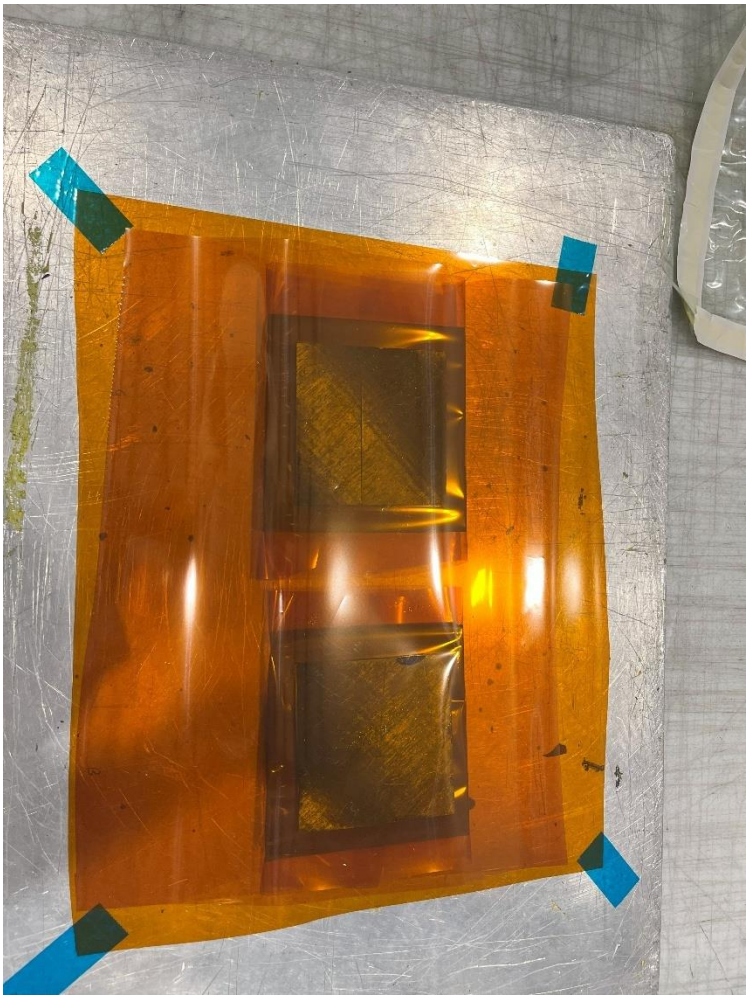


7. Dry clean your original molds for gluing – DO NOT use IPA, you do not want to remove the release.
8. Prepare a sufficient amount of PT2712 to cover all carbon surfaces with an extremely thin layer.
9. Place clean carbon sheet on work surface. Have the Lexan sheet ready
10. Deposit a small amount adhesive on surface of carbon using only your coffee stirrers(do not pour)
    a. Spread with coffee stirrers up to edge, ensure there are no dry spots

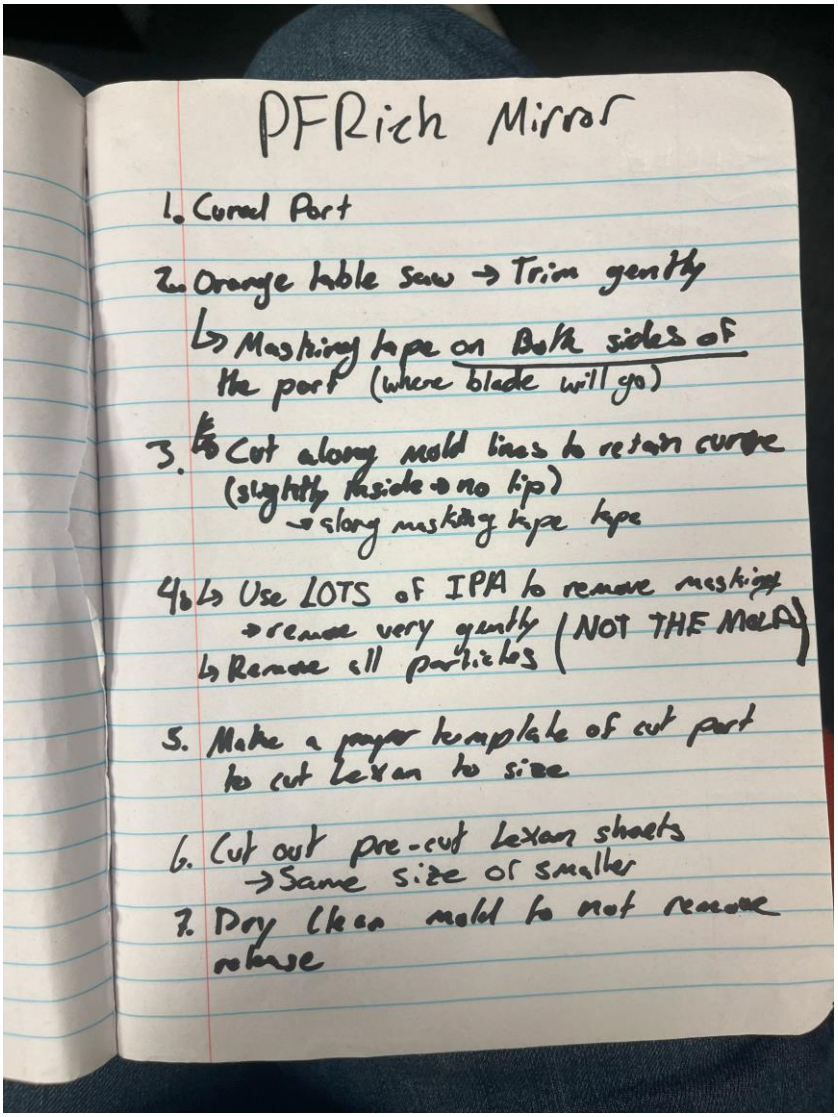
b. 

11. Glue up lexan to laminate, removing ONLY one side of the protective film
    a. Remove protective film from one side of Lexan – handle ONLY from the edges
    b. You may use a piece of blue tape to remove the protective film quickly and efficiently
    c. Bending piece from the sides, place center of Lexan down on center of carbon. Ensure to get even contact, with few air gaps.
    d. 
    e. Slowly releasing tension and laying down lexan, ensure bubbles flow outwards
    f. Small amounts adhesive flowing out of the sides is normal, but should be minimized
    g. Ensure no large airgaps remain inside trapped inside. Small air gaps are acceptable
12. Carefully lift the carbon, leaving excess epoxy behind on work surface. Place carbon on mold

13. 
    a.
14. Clean work surface of excess adhesive with IPA, and return to step 9
15. Once done, place a piece of clean Yellow release on top of all carbon pieces, then breather. Ensure a small piece of breather Is present to the side for the vacuum pump valve.
    a. The final order of everything should be(From top to bottom):
        i. Bag
        ii. Breather
        iii. Yellow Release
        iv. Laminate
        v. PT2712
        vi. Lexan
        vii. Yellow Release
        viii. Tool (mold)
        ix. Yellow Release
        x. Aluminum Plate

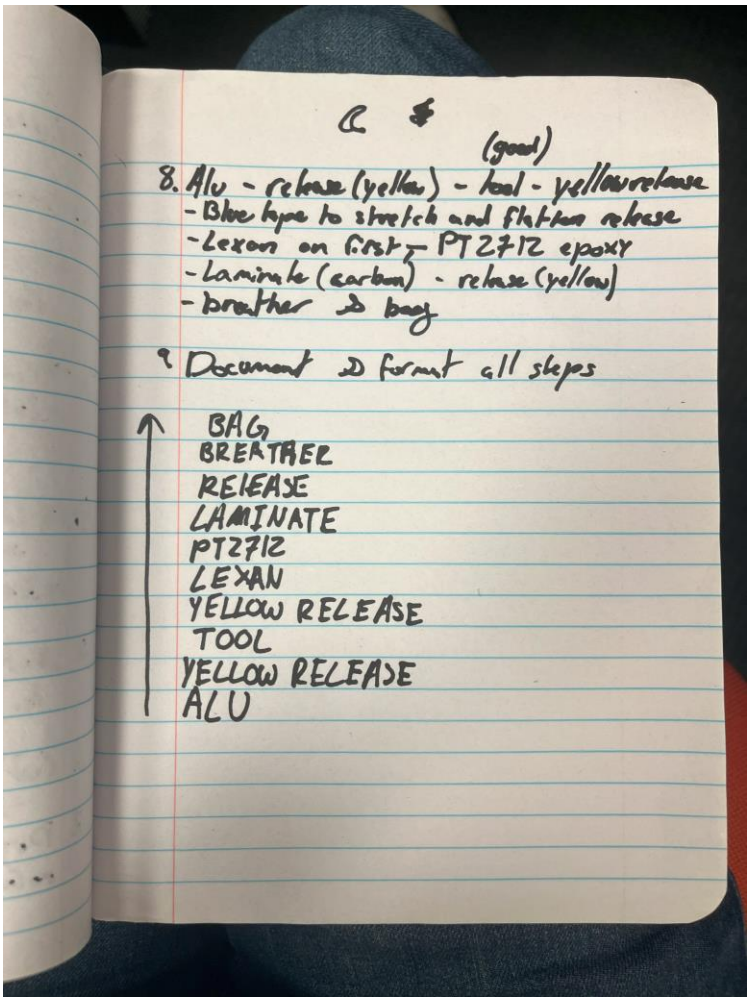
16. 
17. Follow relevant vacuum bagging procedures, let adhesive fully cure under vacuum.
    a. Ensure no folds from the bag lie on top of the pieces, they should be diverted around them

b. 



PFRich Mirror

1. Cured Part
2. Orange table saw → Trim gently
   ↳ Masking tape on Both sides of the part (where blade will go)
3. ↳ Cut along mold lines to retain curve (slightly inside → no lip)
   → along masking tape tape
4. ↳ Use LOTS of IPA to remove masking
   → remove very gently (NOT THE MOLD)
   ↳ Remove all particles
5. Make a paper template of cut part to cut Lexan to size
6. Cut out pre-cut Lexan sheets
   → Same size or smaller
7. Dry Clean mold to not remove release


(good)
8. Alu - release (yellow) - tool - yellow release
- Blue tape to stretch and flatten release
- Lexan on first - PT2712 epoxy
- Laminate (carbon) - release (yellow)
- breather → bag
9. Document → format all steps
BAG
BREATHER
RELEASE
LAMINATE
PT2712
LEXAN
YELLOW RELEASE
TOOL
YELLOW RELEASE
ALU

Results:

a. Good mirror came out great in the middle, with imperfections on the edges and especially corners.
b. Bad mirror still performed very well, with a slight imperfection in the middle and as well on edges

Conclusions:

mold matters more than quality of carbon. Both retained their curvature which is good. Lexan appears to be ok under bending

How to improve:

1. work can be done to improve mold stability, such as fulling surfacing both sides of the mold flat.
2. The parallel cuts for the mold surface should go perpendicular to the gradient, to reduce the effects of z axis movement on the surface quality.
3. More stable UD prepreg could be used to reduce fracturing and chipping, and increase dimensional stability of the mirror through the trimming and gluing process

Clean reflection

Warped reflection