

Making A Mirror Polishing And Figuring Tool

By Allen Malsbury

General:

Polishing a mirror is needed to remove those last small pits left behind by the fine grinding process.

See a nearby tutorial titled, "[Making A Mirror Grinding Tool](#)".

It is very common to use the same tile tool that was used during the grinding process as the pitch lap backer piece. Many mirror makers pour the pitch on the tile face of the tile tool. The tile tool is the right size already and it really can't be used again anyway.

A single pitch lap can be used through the entire polishing and figuring process. Laps can be used to polish more than one mirror provided the second and/or third mirrors are the same size as the first. So take care of the lap, clean it with a brass wire brush and lots of water after each session. Store it in a cool place inside a disposable plastic container by itself, pitch side facing up.

Polishing is done with the Mirror on Top (MOT) using the same 1/3 Center of Center (CoC) stroke as you used to grind the mirror with the tile tool. A good rule of thumb is that you will need 1 hour of polishing for each inch of diameter of the mirror. Therefore you will need at least 6 hours of polishing to polish out a 6" mirror. 12 hours for a 12" mirror and so on.

1. To make the lap you will need optical grade pitch. Pitch comes in differing harnesses. #64 is a common grade for small mirrors. Break up the solid pitch by tapping on the outside of the pitch container with a hammer. Do this with the white lid in place to keep the pitch chips in the container.



2. Pour pitch pieces into a disposable aluminum pan. Cover it. Use an electric hot plate to heat the pitch. DO NOT heat with an open flame gas burner or on the gas stove. The pitch is a mixture of different hydrocarbon compounds. As you heat it, combustible compounds are released. Given the right conditions, these combustible compounds can be ignited by a nearby flame. Work outdoors. Pitch smells a lot like a new asphalt driveway as it is heated. Work in old clothes, there is a very good chance you will get some melted pitch on you somewhere. Wear gloves too.



3. While the pitch is melting into a liquid, make a dam around the used tile tool using masking tape. (In this picture a new backer was formed using dental plaster without tile on it.) Go around twice with the sticky side in. Make sure the end of the tape is doubled over on itself so you can find the end easily. This will be important later. Set this on a LEVEL surface so when you pour the liquefied pitch inside the dam, it will spread out to a uniform thickness



4. Rub a few drops of vegetable oil onto the mirror face. The oil helps to stick the foil to the glass. It also helps when you will be slipping the mirror off the foil in a later step.



5. Place the mirror face up on a flat and steady surface. Cover the oiled face of the mirror with aluminum foil. Rub and make the aluminum foil smooth over the entire mirror face.



6. Check to see if the pitch is melting. Stirring with a wooden stick helps get the last lumps to melt.



7. Once the pitch has completely melted and is a liquid, pour it onto the face of the backing piece. Pour onto the center. The pitch will flow to the edges quickly. You may get some bubbles. Don't try to fix them.



8. Here is the tricky part. You must wait until the pitch cools and gets hard enough to pull the tape off, but NOT so long that it is too hard and no longer a soft plastic-like material. (Press in gently on the pitch through the tape along the edge. If it springs back immediately, it is still a liquid. If it is slow to spring back, it is getting more plastic-like and nearly ready.) The tape must be removed by a series of quick ripping movements. Rip around 1/8 the circumference each stroke. Like you were removing a ban-aid. It should come off cleanly.



9. Now, pick up the lap without touching the pitch. Turn it upside down and press it down while **CENTERED** over the foil-covered mirror face. Some pitch should be bulge out all the way around. Gently pick up the sandwich you have made and get it into some cool water quickly. Don't squeeze it together any more. Also, remember the mirror was coated with oil. It may slip out easily. Hold on to all the parts when moving the sandwich. I often just walk back inside and run water over it in the kitchen sink. Having a cool bucket of water nearby works also.



10. Once the pitch is somewhat hard, you can gently separate the mirror from the foil by sliding it **SIDEWAYS** and off the edge. If you try to pull or pry them apart you will make a dent in the pitch, or worse, pull the soft pitch off the backer. Here is a photo showing the lap after the mirror has been removed and the aluminum foil peeled off too.



11. After you have cleaned up the pitch pouring area and the lap has cooled completely, trim the pitch back to the edge of the backer. A sharp striking stroke is best for this. You will CHIP away the pitch. (It is quite brittle at room temperature.) A stroke much like striking a wood match is about right for this. Aim for the hard edge where the pitch meets the backer. Keep other fingers clear of the strike zone. Wear gloves. Your skin is warm enough to re-soften the pitch chips. Small chips will stick to your hands and arms. They are not easily removed.



12. Next, cut facets into the laps. Use masking tape to mark where you will cut the facets at the tape's edge. Use a single-edge razor blade to scratch a "V" groove all the way across the lap. Try to make the first set of grooves about $\frac{3}{4}$ " to 1" apart. Some mirror makers like to offset the first facet slightly off center. They believe a symmetric pattern of grooves is less likely to create a nice spherical polish and that a more random pattern is better.



13. Use a BRASS wire brush to clean out the grooves between the facets as you cut them. Brass is better than a steel or stainless steel brush when working around glass. If a piece of the steel brush breaks off or becomes imbedded in the pitch, it will scratch the mirror next session. Brass will not. The grooves should be "V" shaped.



14. Cut more grooves at right angles to the first set. A “waffle” pattern results. Brush again, and you are ready for pressing before polishing.



15. Pressing the pitch lap is important and is needed to achieve good contact between the pitch lap and the mirror. Here is a small mirror and lap being pressed together by the weight of a plastic bottle with ten pounds of water in it. That's five quarts. Ten pounds is the right weight for a 4" to 6" mirror.



There are two types of pressing: "Cold" and "Hot".

You cold press before starting each polishing session. Cold pressing is done for at least 5 minutes. You also cold press ANYTIME you "feel" a lack of contact during polishing. I cold press at every 10 to 15 minutes during polishing. This gives my arms a rest, and it keeps the evil poor contact from occurring.

Polishing with poor contact will goof up your nice spherical surface. It may take a long time doing 1/3 CoC to fix a few minutes of poor contact polishing.

To cold or hot press, you place the mirror face up on a level surface. Apply a thin layer of Cerium Oxide slurry to the mirror's face and spread it with your gloved finger. **THIS IS IMPORTANT.** If you forget the Cerium Oxide, the pitch will stick to the mirror face and you will not be able to get the pitch lap off the mirror face at the end of pressing.

Cold pressing is done at room temperature.

Hot pressing is done before using a new lap or when you can't achieve good contact with a cold press for some reason. To hot press, immerse the entire pitch lap in a pan of very warm water for about a minute or two. (The water should not be so hot you can't put your hands in it.) Prepare the mirror with face up. Apply the Cerium Oxide slurry to the mirror face. **DON'T FORGET THE CERIUM OXIDE SLURRY.** Now place the pitch lap face down on the mirror face. Place the weight on the back of the lap backer. Wait two minutes. Remove the weight and separate the mirror from the lap. Again, slide it off sideways.

Now flip the positions to polish. The pitch lap should be on the bottom and Mirror on Top (MOT) for polishing. Use 1/3 CoC strokes. After a hot press, you will have good contact. **REMEMBER** how the glass feels moving back and forth over the mirror after the hot press. It should feel like a steady, uniform resistance. **THAT IS GOOD CONTACT.** When you stop feeling good contact, **ALWAYS STOP** and cold press again.

The final step after polishing and figuring is the application of a highly reflective coating. Almost all homemade telescopes are coated with aluminum oxide. The aluminum oxide is over-coated with a transparent material that protects the aluminum oxide from corrosion. A mirror coating should last at least ten years. At the time this is being written, it costs about \$10 to \$15 per inch of diameter for professionally applied coatings. Contact the author for referral to a local vendor.