

Fiber polishing and tapering procedure

This procedure details how to produce the tapered fibers for fiber-coupled light-emitting diodes (FCLEDs).

There are two sizes of fiber. The thin fiber and the thick fiber. They are stored in a coil, in separate boxes. The thin fiber tends to vary in diameter from 270-330 μm . The 450- μm fiber tends to vary in diameter from 420-470 μm .

Use calipers to measure the diameter of the fibers. For the thin fiber, anywhere between 270 μm and 300 μm is acceptable, unless the order specifies a larger diameter. For the thick fiber, anywhere between 440-460 μm is acceptable.

Choosing and Cutting the Fiber:

1. First, gather your fibers from the stock. You can snap some 30-cm pieces from the coil with your fingers. Be gentle to make sure glass does not fly onto the floor or near you. Place the loose fiber in a secure box where they are easy to grab with your fingers.
2. Pick up one of the fibers, if it is from the 270- μm stock, be very careful with how firmly you hold the fibers, they tend to snap when you're least expecting it.
3. Gently place one end of the fiber between the metal clamps of the caliper. It is best to place the fiber as close to the heart of the caliper (Figure 1.) as possible to get an accurate reading of the fiber's diameter.



Figure 1. Caliper

4. If the diameter of the fiber is not within your desired range, keep sliding the calipers down the length of the fiber until you find a section with an acceptable diameter.
5. Once you identify a section of fiber with appropriate diameter, either mark it with a sharpie or grab the area and it from the ruler.

6. The piece you cut should be at least 7 cm to fit in the taper maker.
7. Place the fiber on a piece of paper and grab your diamond cutter.
8. Gently scrape the fiber in the chosen location with one swipe of the diamond cutter. If you do multiple scrapes in one spot on the fiber, the break will not be even. Only scrape it once.
9. Now, gently pinch the fiber on either side of where you cut it, and carefully begin to pull your hands and the fiber in opposite directions. If the cut is good, the fiber will break in half from this. If the cut is okay, you will need to run your fingers over where you broke it as you pull.
10. Once you have successfully broken your fiber, examine it with a loop under light to make sure it is an even cut. I recommend using 7X Hastings Triplet to get a good view of the fiber. When examining the fiber, you are checking to make sure there are no large breaks running down the outer shell of the fiber. If the cut is uneven on the surface, or there is a very thin small spike of glass sticking out of the end of the fiber, it is acceptable and can be polished down.
 - a. You can. Also use the loose 15- μ m grit polishing paper (grey) to sand down any little glass spikes or discrepancies before you put your fiber in the polishing machine. Wet the polishing paper slightly with water and hold it with your weak hand. With your dominant hand hold the fiber close to the base that you want to polish. Lightly run the fiber in a circle of figure 8 pattern against the wet 15um paper. If you apply too much pressure to the fiber, it will snap, be careful. Examine the fiber to ensure that any major discrepancies have been polished away.

Polishing The Fiber:

1. Once you have an even cut, take your fiber over to the Ultra tec polishing machine. (Figure 2.)



Figure 2. The Ultratec Unipol Polishing Machine.

2. In Figure 2, the fiber polisher has no polishing paper and has two gold weight on its neck. The gold weights are not necessary right now, so if they are there take them off.
3. Get a cup of water.
4. Move the arm of the polishing machine on its backside so you can properly place the fiber through the ferrule and the polishing paper on the stand.
5. Every piece you any need for the fiber polishing machine is in a yellow bucket labeled “Fiber Polishing Machine”. The ferrules polishing paper, and Allen keys are all in this bin.
6. There are 10 ferrule sizes.
 - 290 μm
 - 310 μm : *Best for 290 μm*
 - 330 μm
 - 350 μm
 - 370 μm
 - 390 μm
 - 410 μm
 - 430 μm
 - 450 μm : *Best for 450 μm*
 - 470 μm
7. Once you have chosen your ferrule, retrieve one of the small Allen keys from the bin. Next to the tip of the ferrule on the fiber polishing machine you will see a small hole that allows you to loosen and tighten the grip on the ferrule. Use the Allen key to loosen this bolt and remove the current ferrule and put in the one you have chosen. Return the old ferrule to its properly labeled bag in the “Fiber polishing” bin.
8. Now grab a round, light purple, 1- μm grit polishing paper. Use a drop of water on the bare polishing plate to stick the polishing paper to the plate. The glossy side of the polishing paper is the side that will stick to the metal plate of the polisher. The rough side should face up, towards the ceiling and the ferrule.
9. Confirm that the polishing paper is sufficiently stuck to the polishing plate by taking two finger and pressing the paper into the plate at an angle. If it moves easily then try removing some of the water between the paper and the polishing plate.
10. Now, slide the good end of your fiber through the hole in the top side of the fiber polishing arm (see Figure 3.). If the fiber does not slide right through the hole and out the other side, then try twisting it as you slide it in. Be careful while inserting the fiber, if you insert the fiber then drop the arm onto the plate by accident, the fiber on the other side will snap.
11. Once the fiber is through, position it so about 1mm or less is sticking out of the bottom end of the ferrule. If it is more than 1 mm, the tip of the fiber might snap when you turn on the machine. If it is less than 1 mm, the machine may quickly polish it down to the ferrule, which is fine.
12. Once the fiber is where you would like it to be, turn the black nob on the end of the arm to tighten the holder around the fiber. Do not twist it all the way, this will cause too much tension to be applied to the fiber. Twist it until the fiber is secure not slipping around.

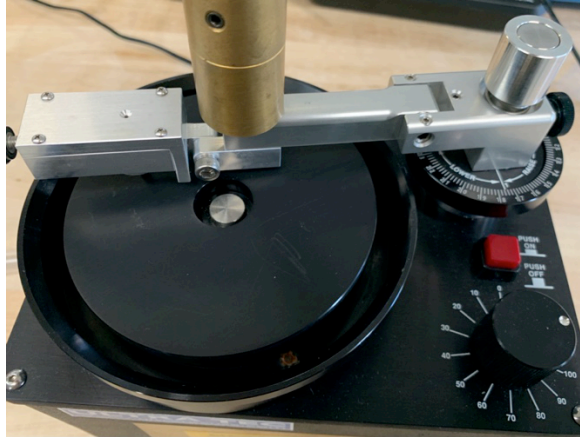


Figure 3. Closeup of Polishing Machine with Fiber Clamp Fixture

13. Gently move the arm back to its position on the polishing plate (Figure 3.).
14. Turn the machine time nob to about 100 seconds and flip the switch on the side of the machine so the plate starts spinning.
15. You can leave the machine running on its own, it will turn off after the time runs out.
16. Once the time has finished, you can examine the fiber while still in the arm. If you see any glaring breaks or scratches, run the machine again.
17. Once you are ready to properly examine it, gently remove the fiber. Clean it with warm water and then lightly blow it dry with the air compressor. When you dry the fiber, hold the polished end between two fingers, just barely exposed, and blow the air from about a foot away.
18. Now examine the polished end under good lighting with your magnifying loop. If you see smudged black scratches on the middle of it, it may be dirt, so try cleaning your fiber again.
19. If the fiber reflects the light perfectly and there are no cracks or scratches in it, your fiber is polished.

Tapering the Fiber:

We create the tapered end of the fiber with our tapering machine, shown below.

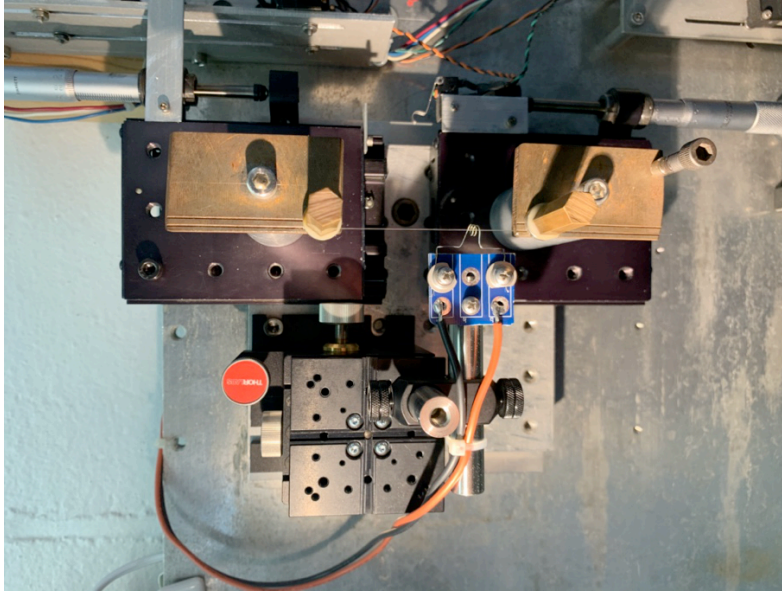


Figure 4: The Tapering Machine.

Turn the machine on and click the “Reset” button. This makes sure that the system does not get confused and properly returns not the Home position.

1. Open the LWDAQ system on the computer. Go to “tools” then “more” and click “tapermaker”
2. Make sure there is no leftover fiber in the tapermaker stand and then Click the “reset” button.
3. Once the Taper maker returns to home position, check your taper settings.

Bottom Home Position	20.0 mm		
Top Home Position	42.00 mm	Top Stretch Delay	0.0 s
Approach distance	10.4 mm	Top Stretch Distance	10.0 mm
Approach Speed	1.0 mm/s	Top Stretch Speed	2.0 mm/s
Approach differential	1.02 mm/mm	Reset Speed	2.0 mm/s
Bottom Stretch Delay	2.0 s	Acceleration	10.0 m/s/s
Bottom Stretch Distance	10.0 mm	daq_ip_addr	10.0.0.38
Bottom Stretch Speed	2.0 mm/s	Daq_driver_socket	1

Table 1. Taper maker 2.6 settings

4. Feed your fiber through the coil (from which direction) and align the polished end with the horizontal line on the bottom stand. (where is horizontal line?)
5. There are two rubber magnet holders. One on the top stand and one on the bottom stand. Once the fiber is in the groove and lined up with the length marker (horizontal line on the

bottom stand), gently place the rubber magnet holders on the fiber to secure the fiber. (See figure 5.)

- a. It is important that the bottom rubber holder does not surpass the top or side edge of the bottom stand because that introduces the risk of the coil burning the rubber on the holder when it approaches the coil.

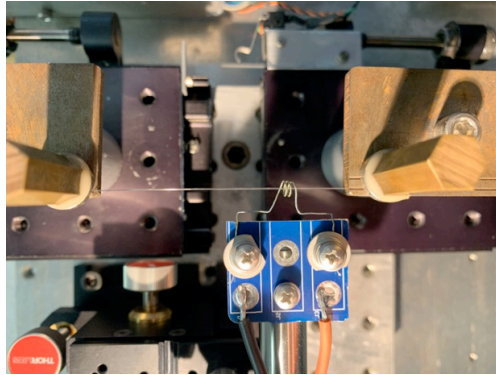


Figure 5. Close up of in place fiber.



Figure 6. Power supply settings.

1. Power Supply settings: With nothing connected to the power supply set the voltage to 4.0 V. Connect the power supply terminals together with a banana cable. Adjust the current to 4.3 A. When you connect the heating coil, it should get bright orange, with the current reaching 4.3 A and the voltage dropping to around 3.1 V.
2. After you click the taper button on the program wait about 1-2 seconds and turn on the power supply.
3. Once the taper is complete and you have two separate pieces of fiber, it is time to remove the tapered polished fiber.
4. Use the small black gel packs to collect the fibers.
5. Hold the open gel pack directly under the taper machine and remove the bottom rubber magnet holder. The small tapered fiber will fall out of its place and should land into the gel pack.