Nathan Kolb

Dr. Abdullatif Hamad

Experiment 6 – Preparing and Inspecting Optical Fibers

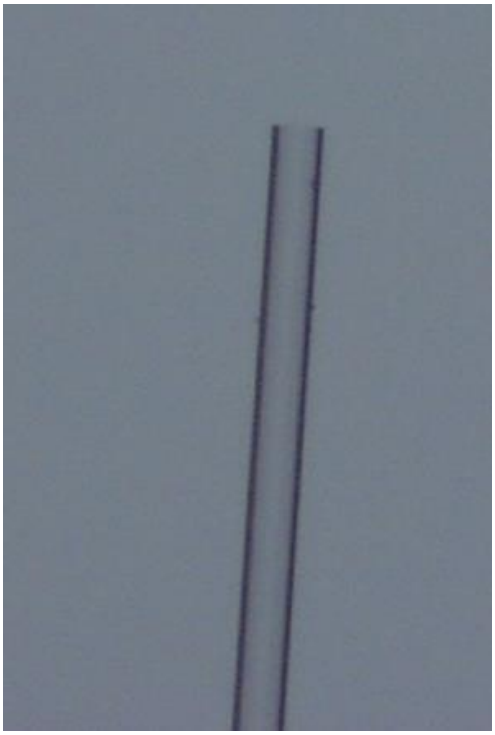
The goal of this lab is to successfully prepare an optical fiber via removing its jacket and buffer, and then cleave the stripped fiber to make it flat. We will then observe this fiber under a microscope.

Task 1: Fiber Preparation:

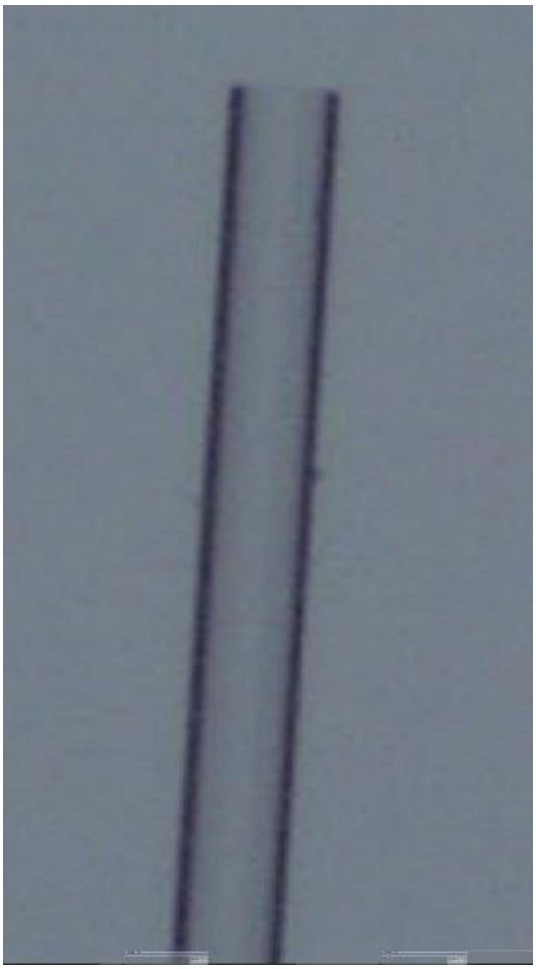
This task is concerned solely with the preparation of the fiber. We will begin with a fiber with its jacket and buffer still intact. We will begin by removing around 2 inches of the fibers jacket with a razorblade by putting the fiber flat on a table, placing a razorblade on top of it with a very shallow angle, and then pulling the fiber through the blade slowly until the jacket is fully removed. We will then be left with the buffer to remove, which we will do so with a fiber coating stripper. We will place the partially stripped fiber into the teeth of the handheld stripper with the arrows pointing upwards. We will then close the stripper and pull the fiber through very slowly and perpendicular to the stripper. Next, we will wipe the exposed fiber off with a chemical wipe soaked in acetone to remove any leftover residue left on the fiber. The final part in preparing our fiber will be to cleave it to make the tips flat. We will do so by placing our fiber into a Fujikura and pressing down so that the blade cuts through some of it at a right angle. We will do these steps for both sides of the fiber.

Task 2: Fiber Examination Using the Microscope:

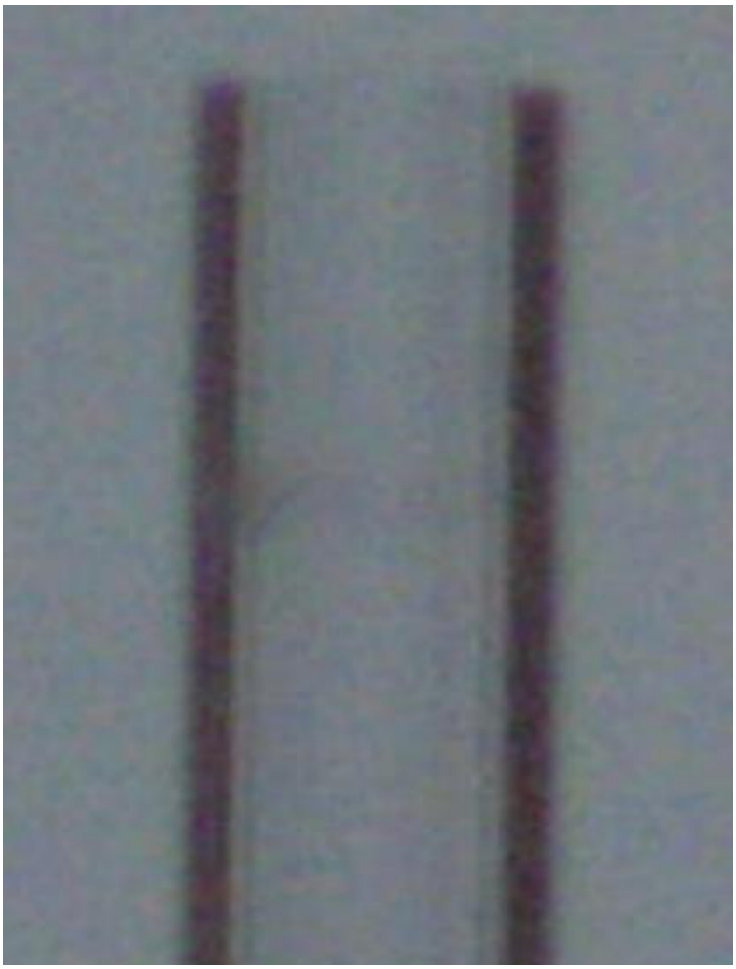
For this task we will place our prepared fiber into the fiber holder, and then place this fiber on a translational stage that can move upwards so that we can get the fiber at the focus of the microscope. We will then place this setup under a microscope, adjusting the vertical placement until we are at the microscope's focus. At 10X magnification, our fiber looked like the following:



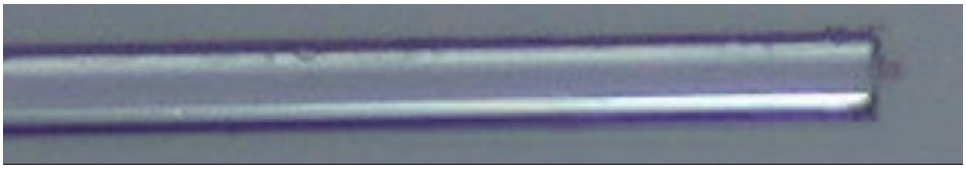
At 60X magnification, our fiber looked like the following:

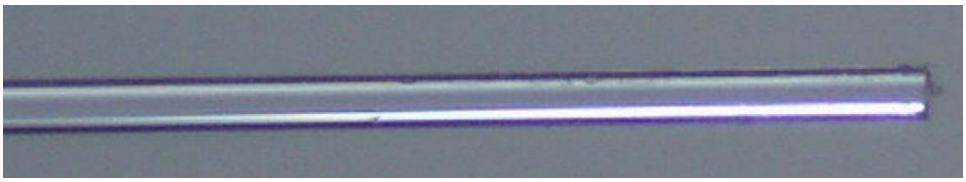


Finally, at 200X magnification, our fiber looked like the following:



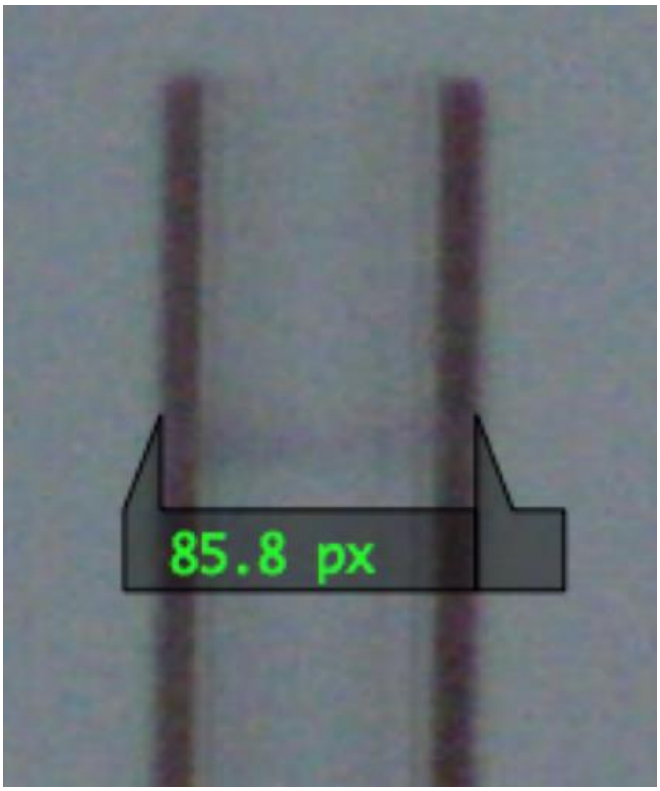
To determine if our cleave is flat, we shined a flashlight through one end of the fiber while observing the other end under the microscope. By rotating the fiber while shining light through it, we know that the cleave is flat if we do not see any light coming out of it from this angle. This is because all the light should be traveling the same way as the fiber if it is flat, which we would not see. From rotating the fiber, we found that no light was traveling out of the side of it, so we know our fiber is cleaved flat. We took a few more pictures of the image formed by the microscope which looked like the following:





Task 3: Fiber Diameter Using Translational Stage and the Microscope:

For this task we will use the built-in Vernier to measure the diameter of the fiber directly. At 200X the Vernier measurement looked like the following:



We must determine how large 1 pixel is to calculate the actual diameter in SI units. Using a wire with a known diameter of 0.62mm, we found that this Vernier measured it to be 444.5 pixels. From this we calculated that 1 pixel = 0.00139mm. Plugging this relation into our value of 85.8 pixels for the fiber, we found that $D(fiber) = 0.120mm = 120\mu m$.

Task 4: Fiber Diameter Using Diffraction:

For this task we will place our fiber directly in front of a laser to obtain a diffraction pattern in the far field. We will then use the equation $\frac{D}{4}\sin(\theta) = m\lambda$ to determine the diameter of the fiber from this diffraction pattern. Since θ is very small, $\sin(\theta) \approx \tan(\theta)$. $\tan(\theta) = \frac{x_m}{L}$, where x_m is the distance from the central maximum to the m^{th} minimum. We can then change our equation to $\frac{Dx_m}{4L} = m\lambda$ and rearrange this to get $D = \frac{4Lm\lambda}{x_m}$. After measuring various distances to the m^{th}

minimum from the central maximum, and measuring L = 157.5cm, we achieved the following data:

m	xm(m)	D(m)	D(um)
1	0.027	0.000147653	147.6533333
2	0.05	0.000159466	159.4656
3	0.078	0.000153332	153.3323077
4	0.12	0.000132888	132.888
5	0.128	0.000155728	155.728125

From this we can calculate $D = \overline{D} \pm \Delta D$, which we found to be $D = 149.8\mu m \pm 12.2\mu m$. This is somewhat consistent with the previous task, with a % difference of 19.9%. The measurement under the microscope is more accurate as we had to measure the center of the minimum for this task, and the ruler that we used only measures out to 0.1cm, so there is much more uncertainty this way.

In conclusion, this lab taught us how to prepare a fiber and how to inspect it to ensure it is good to take measurements from. This skill will be very important for future labs.