MITOCW | Optics: Polarization in a single mode fiber | MIT Video Demonstrations in Lasers and Optics

SHAOUL EZEKIEL: This demonstration, we're going to show the influence of an optical fiber on the polarization properties of light. In this case, we're going to use a normal single mode fiber. The setup is as shown here. We have a helium neon laser. Here's the beam from the laser reflected by this mirror here, then by another mirror here, into a quarter-wave plate and a polarizer. And, in this way, by rotating the polarizer here, I can select any linear polarization I want in this region.

Then what we do is we take the light from here, we pass it through a short focal length lens, focus it into the fiber to the single mode fiber over here, and then the output of the fiber is, again, [INAUDIBLE] by another short focal length lens, and then the output of this lens, and we let go onto the screen. So this is the basic setup, now we're ready to look at polarization effects in fibers.

Now, first, we have to establish the state of polarization of the light going into the fiber. What I'm going to do, take this polarizer and place it over here. And then I'll take a card, place it here. And now I want to rotate the polarizer and the axis. The little white arrow here indicates the transmission axis of the polarizer. So I can rotate polarizer now, and then in this region over here I have now, which means that the state of polarization of light is orthogonal to the direction of this arrow. So indeed we have plane-polarized light as indicated by the arrow over here, which is orthogonal to the one here. All right, so now we've established the-- that the state of polarization is linear going into the fiber.

Now, let's look at the polarization of the light coming out of the fiber. Again, I'm going to take the polarizer and place it over here, the output. And now let's look at the spot in the inset. Here we have the spot in the inset. Now, I'm going to rotate the transmission axis of the polarizer to see what we have. Gee, we have indeed plane-polarized light also coming out of the fiber. So we have plane-polarized light going in and plane-polarized light coming out.

Now, to demonstrate what the fiber does to the polarization in a very dramatic way, all I have to do is twist the fiber by just pushing on it. And you can see that now, just by applying a little stress to the fiber-- now I have changed the polarization because now I have light coming out of the polarizer while before it was not. Now, again, I can push the fiber around some more. As you can see, I can change the amount of light coming through the polarizer, which means that this state of polarization is changing just by simply applying simple stress. I can apply mechanical stress like I'm doing now. I can get the similar effect by heating the fiber and so on so that the state of polarization then can be influenced quite a bit by the environment-- the effect of the environment on the fiber.

You can see here I can make it come out very bright through the polarizer when originally it was not. Here we are [INAUDIBLE] now zero, which it means plane polarized. Now, it's some state of polarization. In fact, I'm going to hold it-- hold the fiber in this position, and then now I'm going to go and I'm going to turn the polarizer to see indeed do I have plane-polarized light or elliptically polarized light. Well, it's elliptically polarized light because I can't [INAUDIBLE]. So now I have changed this state of polarization then from linear to elliptical. And, again, if I put more stress on the fiber, let's see now what state polarization I get now? Again, you can see it is elliptical because I can't [INAUDIBLE].

So in conclusion then, the-- a single mode-- irregular single mode fiber can change the state the polarization of light going into it into almost anything, to plane polarized, circular polarized, elliptically polarized. And this is influenced greatly by the environment that the fiber is in. So it's very difficult to maintain then a good state of polarization or a known state of polarization in a single mode fiber because of these environmental disturbances. If one wants to maintain, let's say, linear polarization, one would have to use a polarization maintaining fiber.