MITOCW | Optics: Single mode fiber | MIT Video Demonstrations in Lasers and Optics

PROFESSOR: In this demonstration, we're going to illustrate the propagation of light in a fiber-- a glass fiber. As we know, today, optical fibers have a lot of low loss-- very low loss-- of the order of 1 to 2 dBs per kilometer. And, of course, they're being used for communication, as well as other applications, like sensors.

So the setup we have is a is a laser-- a helium-neon laser-- over here. Here's the output from the laser. We're going to reflect it by this mirror and this mirror and then pass it through a lens. This lens over here focuses the light into the fiber end.

And if we can take a close-up of what's going on over here, what you would see is then a lens-- this lens-- then focusing the light. And the fiber is very close to the lens. And then the rest of the fiber is here. So here is the rest of the fiber.

Now, this fiber-- in fact, what you're seeing over here is essentially the plastic jacket. The fiber core is about four microns in diameter, and the cladding is 125 microns. And the rest that you see here is the plastic jacket. That's why it looks so visible, because it's so thick.

The other end of the fiber then goes into this holder in the chuck here. It's a fiber hold in a chuck. And the output of the fiber then is over here onto this little screen.

Now, if we can, maybe we can take a close look at the fiber end here. What shows that-- what you see over here-- in fact, let me point to it-- is the cladding. Essentially, we've stripped the jacket, and what you see here is just the cladding. And this is the 125 microns. While over here is the fiber with the plastic jacket. So when you remove the plastic jacket, then you have essentially what you're seeing is just 125 micron cladding.

So this is then the fiber. And there's the output of the fiber. Now, what we see, if we can then enhance this and bring it in, is the single-mode behavior of a fiber. And it looks almost like a Gaussian kind of spot. Not quite Gaussian, but looks like a Gaussian kind of spot.

Now, what I'm doing now is just adjusting the coupling into the fiber. And it's very touchy, because, as I said, the core is only about 4 microns. So this is what then a single-mode fiber-- the output from a single-mode fiber-- looks like.

And as I misalign a line here, it doesn't make any difference. All you get is just a loss in intensity. The shape of the mode stays the same. So, remember, the core is 4 microns, cladding is 125, the wavelength of the light is 6328 angstroms, and the core to index difference is about 1 part in 10 to the 3. So this way you can show that, indeed, you get single-mode propagation.

Now, I would like to illustrate some interesting phenomena about fiber. So if we get the camera to look over here, I want to illustrate how touchy is the propagation of light in a single-mode fiber. Now, here is a piece of fiber, and you can see that there's no light scattered from the fiber. Now, all I have to do is bend the fiber, and you're beginning to see light that gets transmitted out of the fiber-- gets essentially kicked out the fiber because of the bend.

And the reason for that, because you start going against the rules of propagation of light in a fiber. For example, if you take the ray explanation, is that what you're doing, you are exceeding or you're changing the angle of light with respect to the fiber. Which means that if you are below the critical angle, then the light is no longer totally internally deflected and therefore gets kicked out.

So here it is. It's very dramatic. As soon as you put this little bend in this fiber, you can you can kick out a lot of light. In fact, there's the glow right here.

Now, if we can bring in the output of the fiber into the inset over here, now you can see that, as I increase the bend, you can see that the intensity-- here, I'll do it even more-- then drops quite a bit. Which means I've kicked out almost all the light by simply putting a bend into the fiber. So the illustration here then shows that if you leave the fiber alone without the sharp bends, everything is fine. If you put in a bend, then you can kick out a lot of light, and then not much will be transmitted. So you have to be careful you don't put it too tight of a bend, otherwise you fiber is brittle, and you break the fiber. So you have to be careful how you do this.

So in this demonstration, we've seen how single-mode by fiber behaves. In the next demonstration, we're going to bring a another fiber with a different-sized core, and we going to see what comes out from that fiber.