Experiment No. 16
Splicing of optical fibers

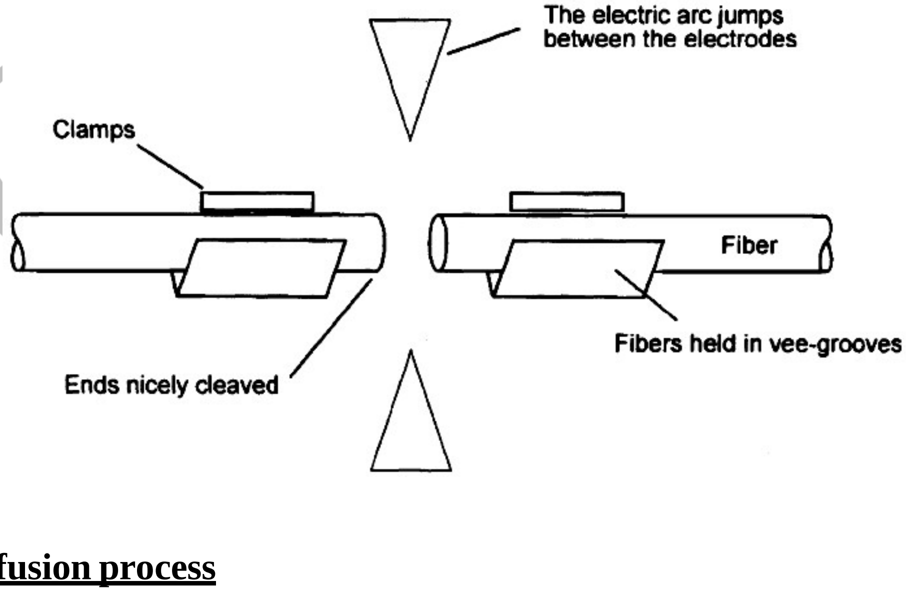
Aim: The aim of this experiment is giving the skills for splice the glass optical fibers.

Apparatus

1. Splice fusion set.
2. Two optical fibers.
3. Optical power meter

Theory

Fusion splicing is the most permanent and lowest loss method of connecting optic fibers. In essence, the two fibers are simply aligned then joined by electric-arc welding (*The arc that occurs between the two electrodes is about 7000 volts with an adjustable current up to 25 mA*). The resulting connection has a loss of less than 0.05 dB, about 1% power loss. Most fusion splicers can handle both single mode and multimode fibers in a variety of sizes, but due to the losses involved, we only splice multimode to multimode or single mode to single mode. There are also splicers that can automatically splice multi-core and ribbon cable up to 12 fibers at a time.



Splicing fusion process

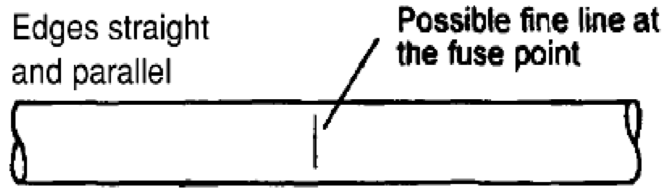
The fibers must first be stripped, cleaned and cleaved. To allow spare fiber for easy access and to allow for several attempts, a length of at least five meters of jacket should be removed. The primary buffer is only stripped to about 25 mm. The exact length is determined by the fusion splicer in use.

After the fiber is cleaned and cleaved then the vee-groove is cleaned by a lint free cloth, tissue or a ‘cotton bud’ moistened with isopropyl alcohol. The fiber is gently pressed into the vee-groove by a magnetic or gravity clamp. Once the fibers are safely clamped into their vee-grooves, they are moved, vee-grooves and all, until the fibers are aligned with each other and positioned directly under the electrodes from which the electric arc will be produced. We are aiming to achieve positioning with an accuracy of better than 1 μm.

All fusion splicers are fitted with some means to observe the fiber positioning and the condition of the electrodes. This is achieved by either a microscope or by a CCD camera (CCD = charge coupled device - a semiconductor light sensor) and a liquid crystal display (LCD). The trend is towards CCD cameras since they are more pleasant to use and have the safety advantage of keeping our eyes separated from the infrared light which can, of course, cause irreparable damage to the eyes if we accidentally observe an active fiber through the microscope.

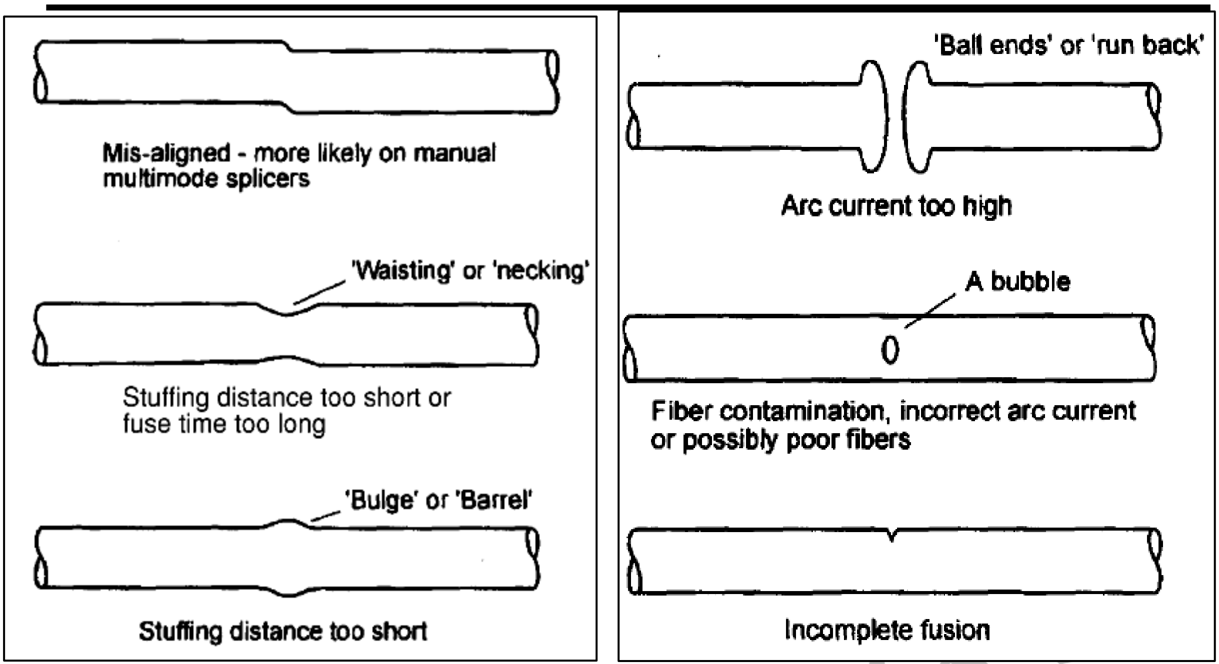
The main fusing arc is more powerful and lasts for a longer period of time, between 10 and 20 seconds.

Once fusing is completed, have a good look at the splice. If it is difficult to see where the splice is, then it’s probably a good one (Figure below). We are looking for the outer edges of the cladding to be parallel, just like a new continuous length of fiber. Sometimes a small white line appears across the core but this is not important and can be ignored.



This is what we hope to see

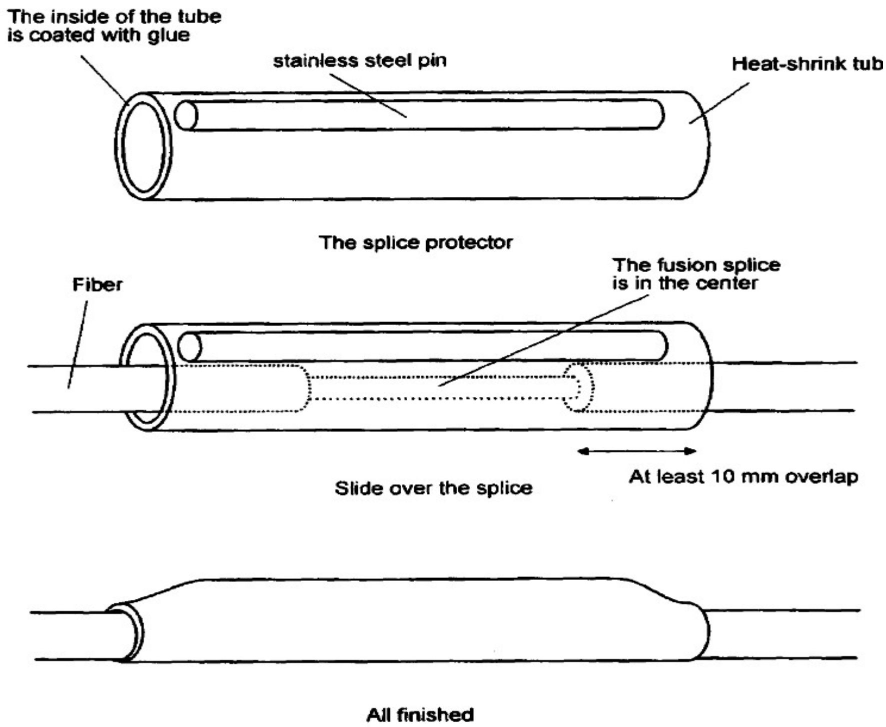
If it is appear at shown in figure below, then it’s a worst one. In this case, it must be re-splice the optical fibers until we see the spliced fibers as shown in figure above.



Splicing disasters!

Splice protector

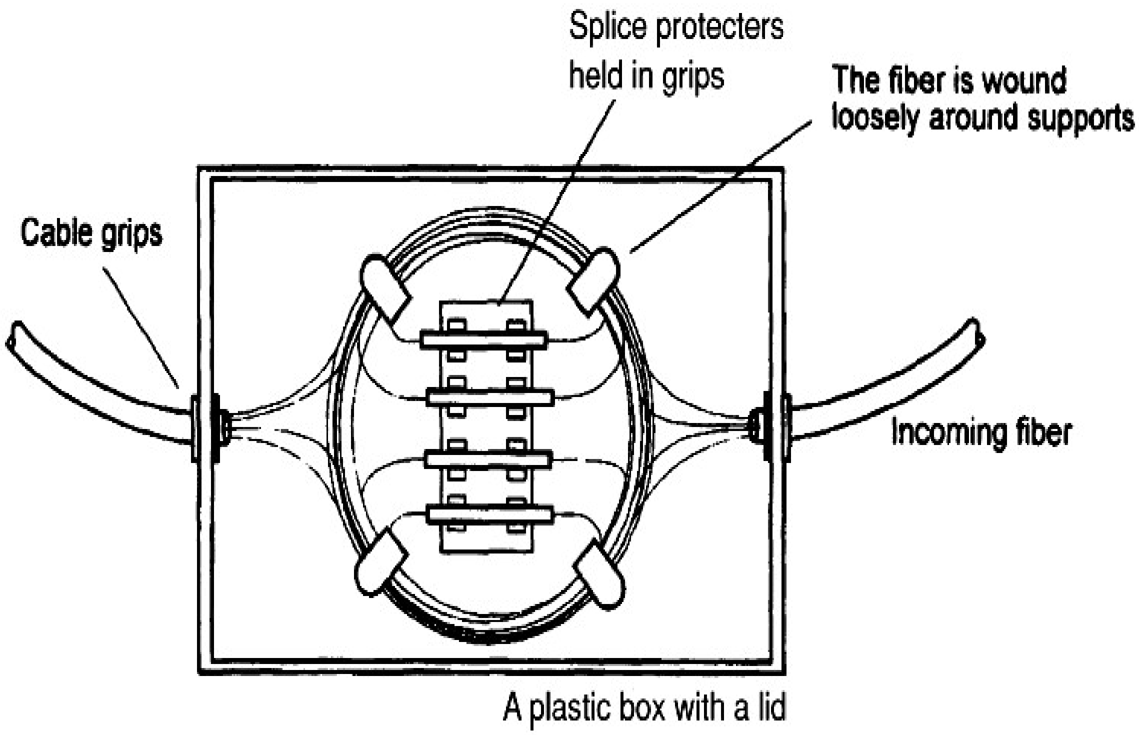
In the preparation phase, we have stripped the fiber of all its mechanical and waterproof protection. Once the fiber has been spliced, some protection must be restored since the splicing process will have reduced the fiber strength to less than 30% of its former value. This is achieved by a device called a splice protector. It consists of a short length (about 60 mm) of heat-shrink sleeving enclosing some hot-melt glue and a stainless steel wire rod as seen in Figure below.



Prior to joining the fiber, the splice protector is slid onto the fiber. After the splice is completed, the protector is centered over the splice and heated, usually in a purpose-built oven although a hot-air gun can be used. The oven is a simple tray with a lid, a heater and a timer which are normally built-in features of the splicers. The hot-melt glue keeps the protector in position whilst the stainless steel rod provides proof against any bending that may occur. The outer sleeve offers general mechanical and water protection to replace the buffer that has been removed. To ensure that the fiber is fully protected along its length, at least 10 mm of the protector must overlap the primary buffer at each end of the splice.

Enclosure

After the splice is completed, we are left with a length of fiber deprived of its outer jacket. The fiber must be protected from mechanical damage, and from water. This is achieved by an enclosure. They are readily available in different sizes to hold everything from 4 to 240 fibers. Each fiber must be identified; otherwise a simple job could become a real nightmare. This is achieved by attaching labels to the fibers or splice protectors and by using colored splice protectors.



Procedure

1. Consult the instruction books of the splicer and the splice protector to find the recommended stripping lengths of the primary buffer.
2. Strip off the outer jackets and the required length of the primary buffer.
3. Slip on a splice protector.
4. Clean the fiber.
5. Cleave it.
6. In a typical case, the fibers are inserted into the vee-grooves and moved until the ends of the fibers meet guide lines visible through the lens or camera.
7. Clamp fibers in position. Have a look at the standard of cleaves and, if necessary, take the fiber out and try again.
8. Set the splicing program to match the fiber in use. The handbook will provide guidance.
9. Press the start button and leave it to it. The program will run through its positioning and splicing procedure, and then stop.
10. Carefully lift it out of the vee-grooves and slide the splice protector along the fiber until it is centered over the splice. Make sure you have at least 10 mm of primary buffer inside the splice protector and place it gently in the oven.
11. Switch on the oven and in a minute or two it will switch off.

Discussions

1. Comment on your results
2. What advantage of using a CCD camera in splicing fusion set?

Explain the benefits of the splice protector and the enclosure