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REDUCTION OF REFLECTION LOSSES IN FIBER-TO-FIBER CONNECTORS

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Abstract- In this paper, a technique is used that reduces the reflection losses in the optical connectors by doing an anti-reflection coating of MgF2 on the connectors. The technique used shows the results of the coating, that how the losses are reduced by the help of anti reflection coating of MgF2 on the connectors in the first window (850-950nm).
Keywords- Optical fiber, splices, optical connectors, connector losses, anti reflection coating, reflection losses, MgF2 coating, first window (i.e. 850-950nm).

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Introduction

Splices

Connections are normally quite simple in metallic systems. Wires can be spliced very easily by soldering. The splice can even be undone by melting the solder. Similarly; fiber-to-fiber connections are needed for a variety of reasons. Several fibers must be spliced together for links of more than a few kilometers because only limited continuous lengths of fiber are normally available from manufacturers [8]. Thus, splices are generally permanent fiber joints. So, the problem with the splices is that the two fibers cannot be detached easily and reconnected with the same ease.

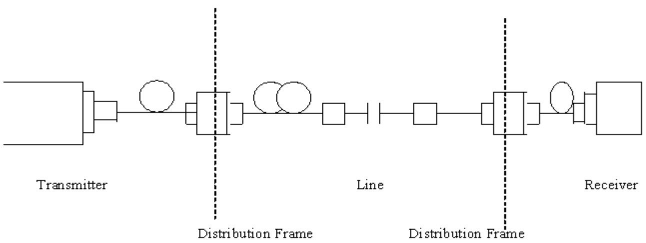

Fig. 1- Basic diagram of splices & connectors

Also, it is a time consuming process and requires extra efforts. Therefore, the need arises to have fiber-to-fiber connections, which are attachable and detachable when desired. This is what exactly a connector does.

Basic Splicing Techniques

Basic splicing techniques include fusing the two fibers or bonding them together in an alignment structure. The bond may be provided by an adhesive, by mechanical pressure, or by a combination of the two.

Fusion Splicing

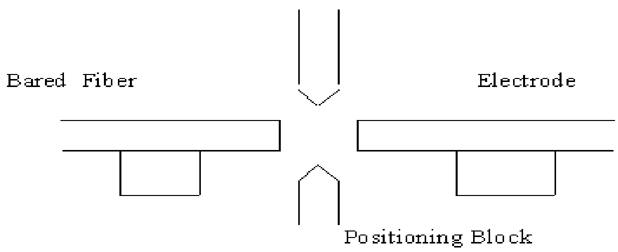

Fig. 2- Diagram showing electric arc fusion

Fusion splices are produced by welding two glass fibers. Commercial fusion machines use an electric arc to soften the fiber ends. The ends are prepared by the scribe-and-break method. Alignment is obtained by adjusting micromanipulators attached to the fibers [8]. The alignment is visually inspected with a microscope.

Adhesive Splicing

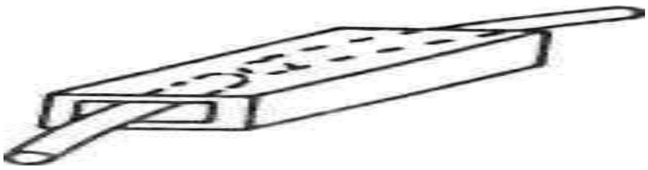

Fig. 3- Diagram showing the adhesive splicing

A number of alignment configurations have been suggested for splices using adhesive bonding. Each of these structures mechanically aligns the fibers and provides strength to the joint [7]. The fibers are held in place by epoxy. Because the epoxy must be cured, these splices cannot be used immediately. Curing
times can be reduced by application of heat or, for some epoxies, exposure to ultraviolet radiation.

Rotary Mechanical Splice

Ferrule Alignment clip Ferrule

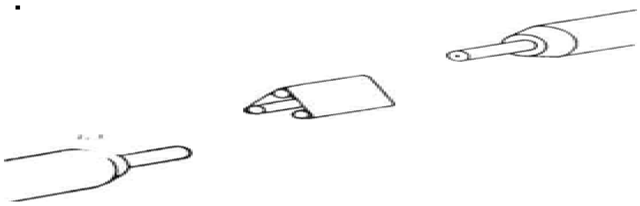

Fig. 4- Rotary Mechanical Splice

A splicing technique that does; not use a precision-machined structure to align the fibers directly is the rotary mechanical splice. In this splice, three rods in a bronze alignment clip secure the ferrules. The holes in the ferrules are not centered, so that the two fibers can be aligned by rotating the ferrules while monitoring the transmitted power. Since the ferrules arc transparent, they can be fixed in place with an UV-curable.

Connectors

A connector for optical fibers is a jointing device that ensures efficient coupling between the two fiber ends or two groups of fiber ends, permitting easy manual mating and demating, whenever necessary. Permanent splices are typically found along a transmission line, whereas demountable connectors are more likely to be located at a distribution frame and at the transmitter and receiver [5].

Types of Connectors

- Butt joint connectors
- Multichannel connectors
- Lensed connectors

Butt joint connectors

These connectors consist of a ferrule for each fiber and a precision sleeve into which the ferrules fit. It is of 3 types:

- Straight-sleeve connectors
- Tapered-sleeve connectors
- Overlap connectors

Multichannel Connectors

Fig. 5- Multichannel Connector

Multichannel connectors can be easily constructed. The simplest example is a two- channel connector, which is convenient for duplex systems in which information is carried in one direction in one fiber and in the opposite direction in the second fiber.
The overlap design can accommodate two fibers if it contains sections with two parallel grooves rather than one. The overlap concept could be extended to more than two channels if there were additional grooves [7]. Multichannel connectors may use the straight or tapered-sleeve approaches in what might be called the bayonet style.

Lensed connectors

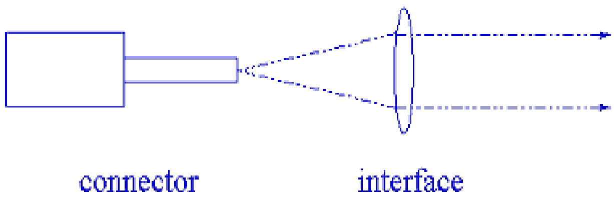

Fig. 6- Diagram of Lensed connector

The expanding beam radiating from the transmitting fiber is collimated by a lens. The: fiber-to-lens distance is equal to the focal length, as required for collimation. An identical arrangement exists at the receiver. This configuration is an imaging system with unity magnification, regardless of the spacing between the lenses [6]. The lens separation cannot be arbitrarily large because off-axis rays do not enter the receiving fiber at the same angle that they left the transmitting fiber unless the lens separation is twice the focal length.

Losses Due To use of Splices & Connecters

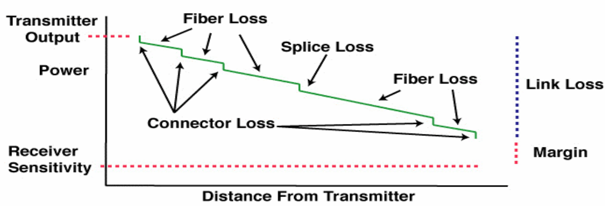

Fig. 7- Diagram showing the losses due to the use of splices & connectors

These losses can be reduced by applying the anti-reflection coating of MgF_2 over the connectors [1]. By increasing the number of layers these losses can be reduced further. With the help of simulation tool "C" the results are as follows:-

Formula Used

Collins Formula

It is used to calculate the refractive index of second layer coating:-

$n_2/n_1=[n_s/n_0]^{1/2}$

where:

n_s- Refractive index of substrate

n_0- Refractive index of air

n_1- Refractive index of first layer

Simulation Results

Graph between Reflactance & Wavelength When There Is No Coating:

Range: 800 to 950 nm

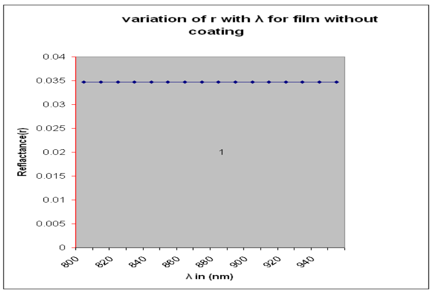

Fig. 8- Graph between reflectance and wavelength whenthere is no coating (800-950nm)

Graph between Reflactance & Wavelength When There Is a Single Layer Coating of MgF_2:

Range: 800 to 950 nm

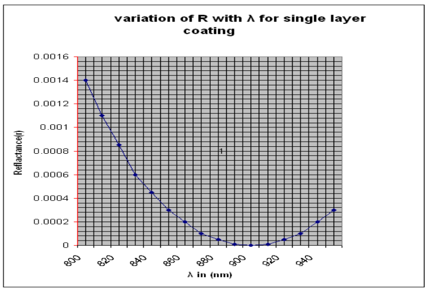

Fig. 9- Graph between reflectance and wavelength when there is a single layer coating of MgF_2 (800-950nm)

Graph between Reflactance & Wavelength When There Is a Two Layer Coating of MgF2:

Range: 800 to 950 nm

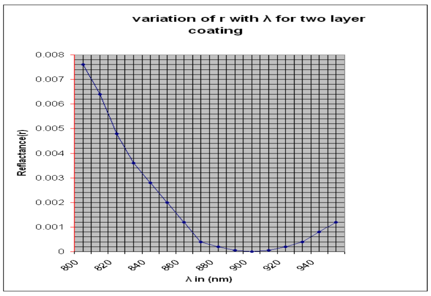

Fig. 10- Graph between reflectance and wavelength when there is a two layer coating of MgF2 (800-950nm)

Graph between Reflactance & Wavelength When There Is a Three Layer Coating of MgF2:

Range: 800 to 950 nm

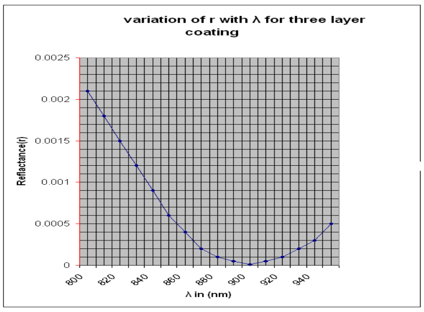

Fig. 11- Graph between reflectance and wavelength when there is a three layer coating of MgF2 (800-950nm)

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