Optical Waveguides and Splicing

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Abstract

In previous years, the Metcalf group has conducted successful experiments examining forces from biochromatic light, adiabatic rapid passage (ARP), and stimulated Raman adiabatic passage (STIRAP). Parts of these experimental setups have been damaged with time, requiring maintenance or replacement. Specifically large sections of optical fibers have produced poor transmission, or need new connections, significantly hampering any attempt to conclusively measure these or other phenomena.

Introduction

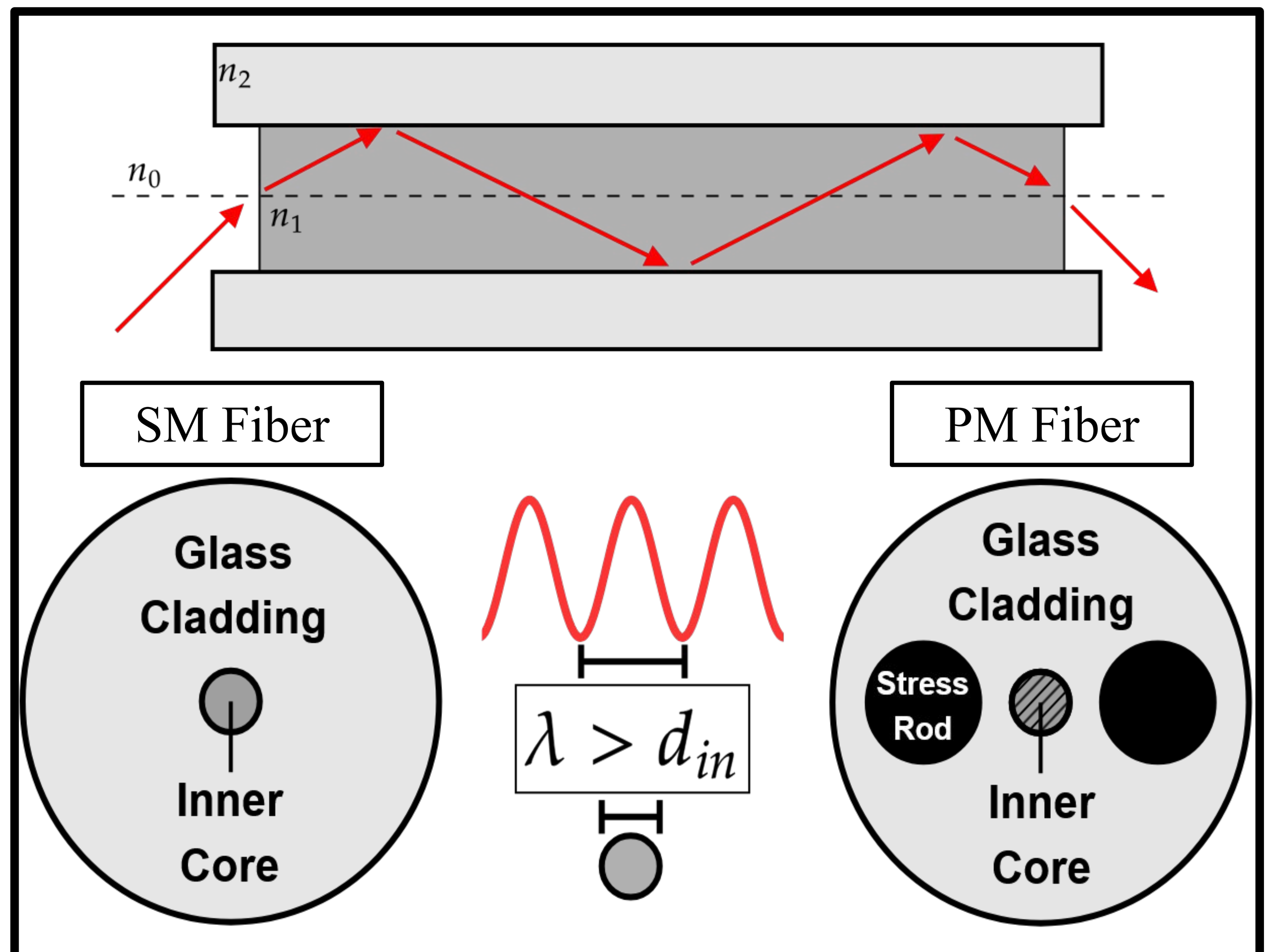
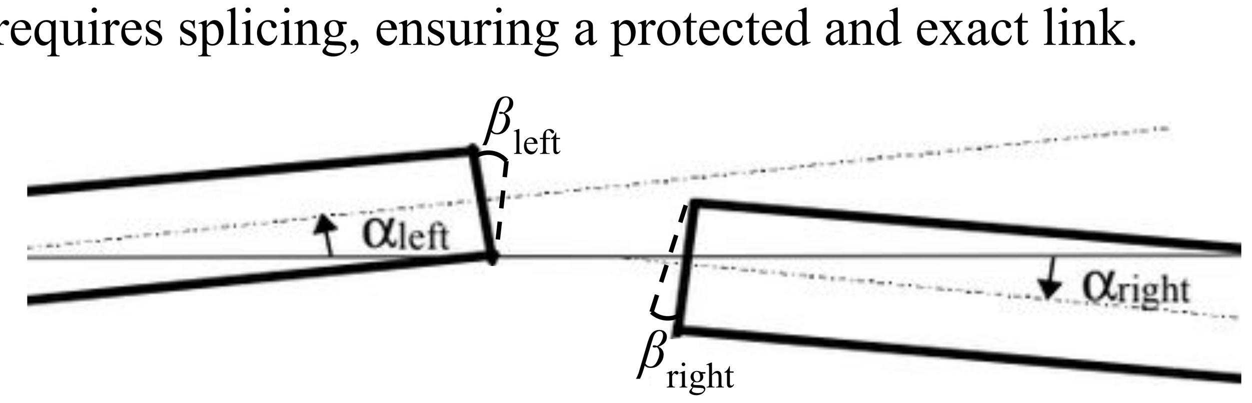


Fig 1. Light propagation through cylindrical waveguides and the used property maintaining fibers of single mode (SM) and polarization maintaining (PM) fibers.

Proper replacement and reconnection of the fiber network requires splicing, ensuring a protected and exact link.



The most important variables when conducting a splice are:

- View Angles (α)
- Gap Angles (β)
- Environmental Factors

(As suggested from the Ericsson splicing manual)

Where any deviation or deformity can cause extreme loss.

Fiber Splicing and Transmission Tests

Three tools were used to splice fibers; a hot stripper, cleaver, and a splicer. Test fibers used to measure transmission loss were created through the following procedure:

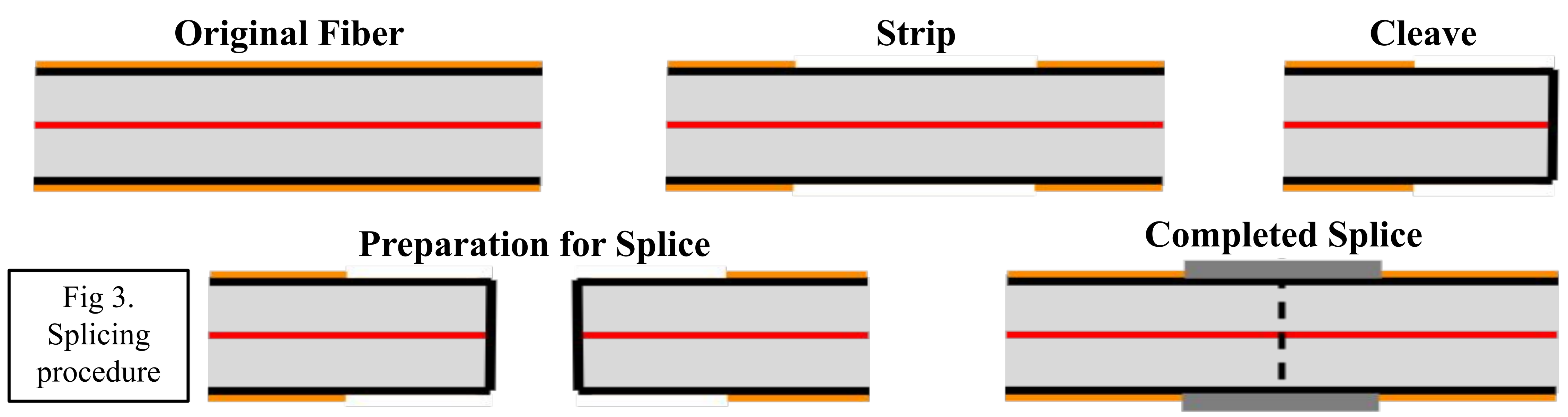


Fig 3. Splicing procedure

During the splice, the splicer rapidly heats the fibers, melting their cores and cladding into each other without mixing. This suggests that if the view or gap angles are off, the fibers will fuse incorrectly..

It is also imperative to avoid particulate matter like dust and moisture from contacting either the fiber or the interior of the splicer, as they can completely destroy a splice during the fusing process.

These completed fibers were tested using the master laser, comparing its input and output power.

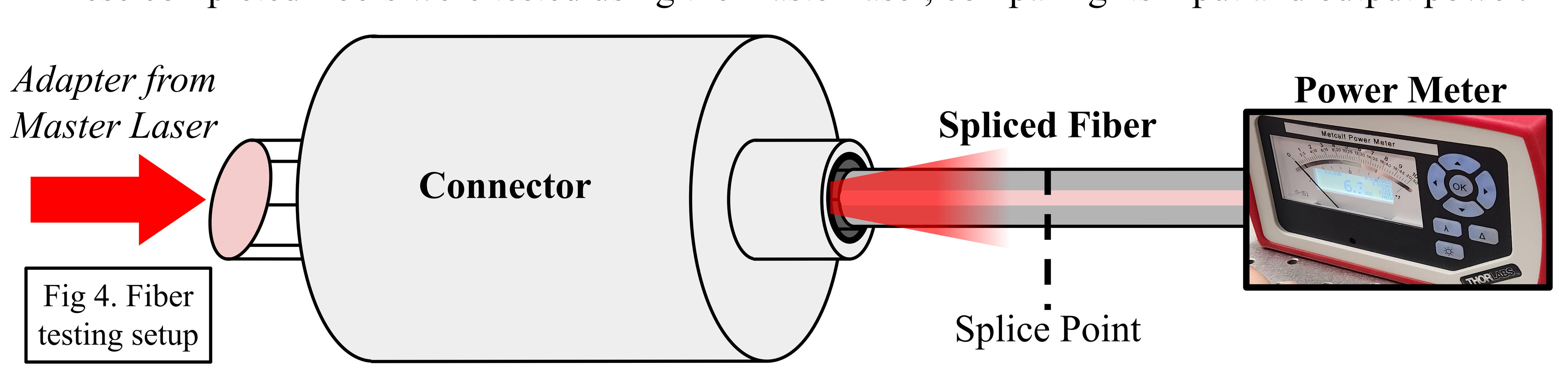
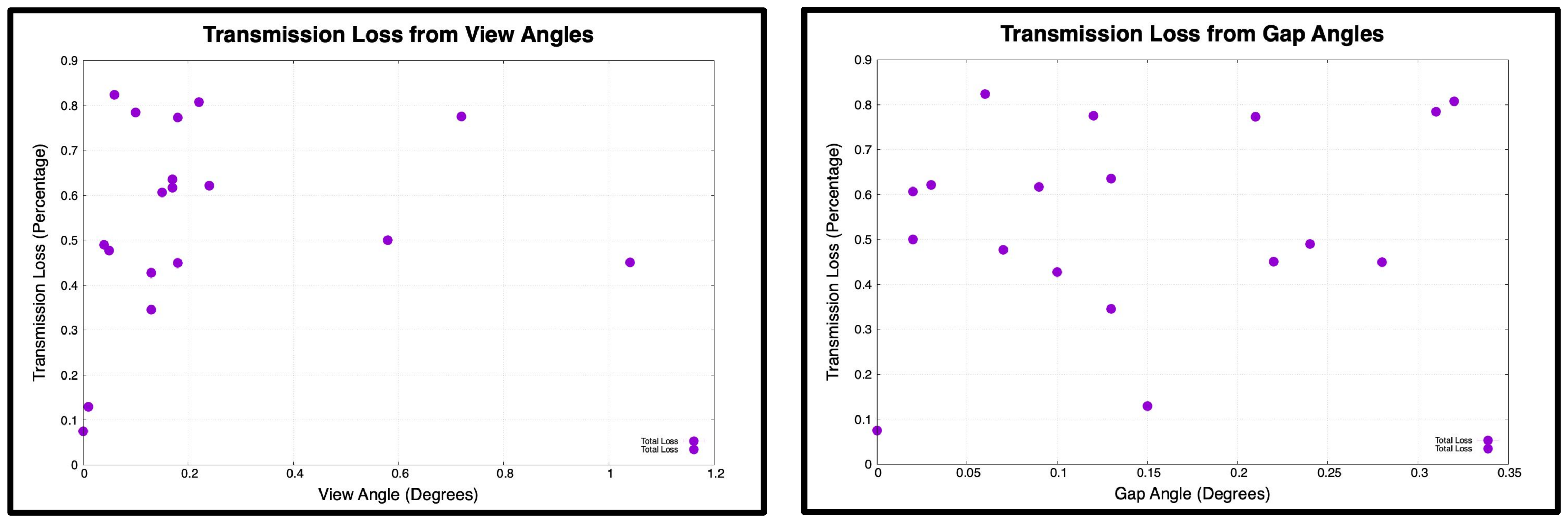


Fig 4. Fiber testing setup

Transmission Loss



$R^2 = 0.029$

Fig 5. Fiber power loss plots

$R^2 = 0.082$

Even accounting for environmental variables, which the splicing process is susceptible to such as humidity, and temperature, do not produce better coefficients of determination (R^2).

Discussion

Abnormalities (shown below) were common during our tests, drastically decreasing any potential power transmission. Additionally intrinsic properties of a fiber could influence the success of a splice, or any deformities.

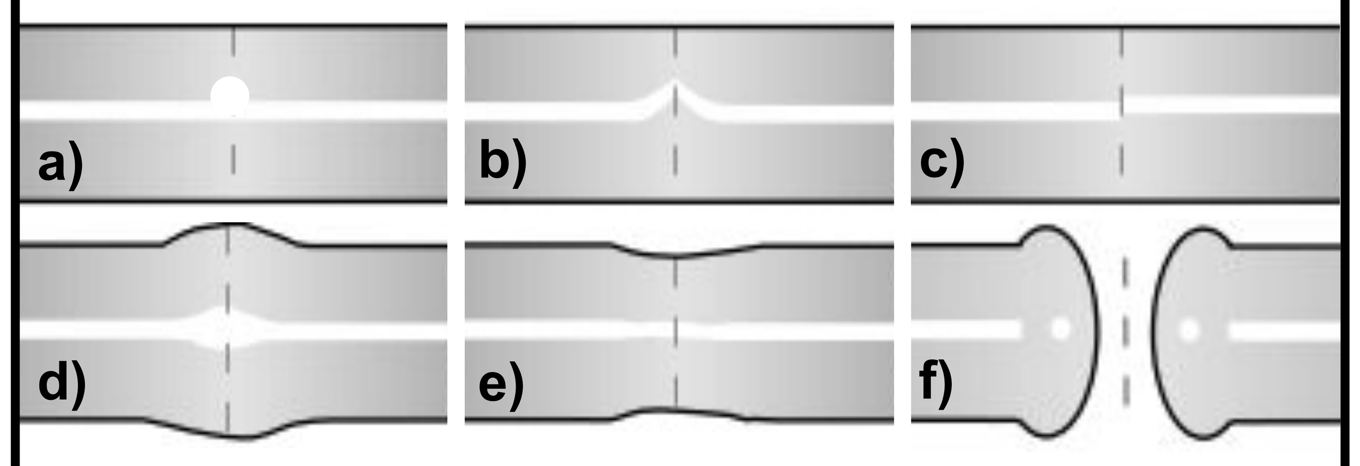


Fig 6. Common splicing abnormalities include: hot spots (a), bowing (b), core offset (c), bulging (d), waisting (e), and matchsticking (f).

Successful coupling of the fiber into the connector (Fig 4) was also a significant cause of transmission loss.

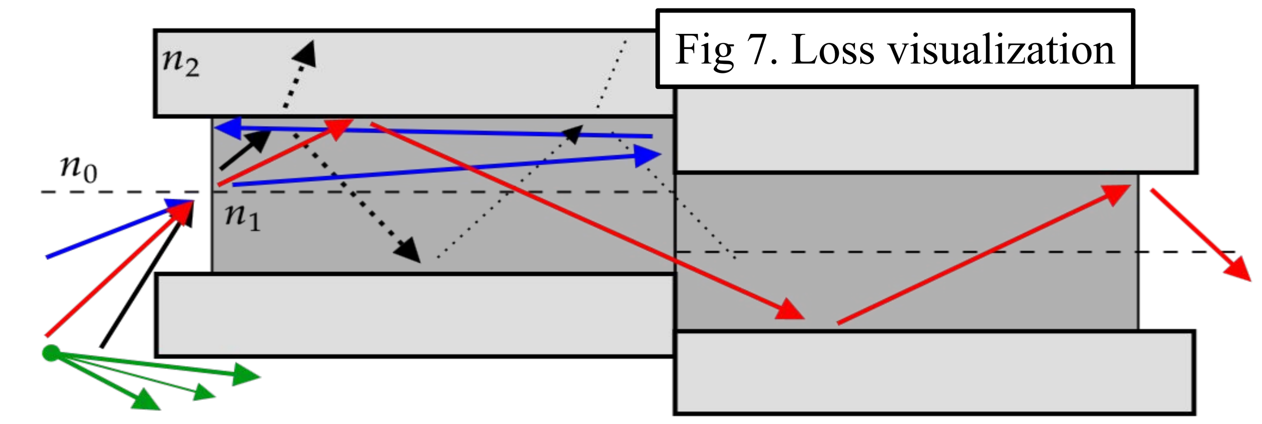


Fig 7. Loss visualization

Improper insertion, or damage to fiber ends can decrease coupling performance, and thereby power transmission.

Acknowledgements

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References

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