Corning® SMF-28® Ultra Optical Fiber Fusion Splicing Report

Application Note

AN2008
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ISO 9001 Registered

Objective

Corning routinely conducts fusion splicing studies for our optical fiber products. In this report Corning tested the fusion splice performance of Corning® SMF-28® Ultra optical fiber. This fiber is compliant with ITU-T Recommendation G.652.D and G.657.A1, in which enhanced low-loss and bend technologies are combined. Please note, some of the product splice combination tests were completed and previously reported by AFL (Alcoa Fujikura Limited).

Test Plan and Procedure

This splicing study involved homogenous (same fiber type) and heterogeneous (different fiber types) splices. All fiber splices were completed using a commercially available active core alignment fusion splicer, using a standard pre-set factory program. The splice loss measurement when using an Optical Time Domain Reflectometer (OTDR) requires the loss of the splice to be measured in both directions in accordance with IEC 60793-1-40. These unidirectional loss values are then averaged to determine the actual loss of the splice; this is known as the bidirectional average. The distribution of unidirectional loss measurements is broader than the distribution of bidirectional average values as it contains so called “gainers” (where the trace at the splice appears to spike upwards) and “exaggerated losses” caused by MFD mismatch of the fibers at the splice. Gainers are conventionally reported as a negative value. Large unidirectional OTDR loss and gainer values are not necessarily an indication of a poor splice and calculation of the bidirectional average is required to deliver an accurate assessment of the splice loss. Because heterogeneous splicing often entails splicing between two entirely distinct MFD ranges, both unidirectional and bidirectional distributions tend to be wider than for homogeneous splicing.

Details of the fiber combinations and the respective quantities can be found in Table 1. For each splicing combination, multiple fibers were used spanning a range of mode field diameters to simulate field conditions.

Note: Some older splicing machines may not recognize ITU-T G.654.E type fibers with large MFD (larger effective area) values, which may result in various machine error messages during fusion splicing attempts. If a splicing problem is observed, it is recommended to use a cladding alignment or multimode recipe setting in order to achieve good splicing results with G.654.E-type fibers.

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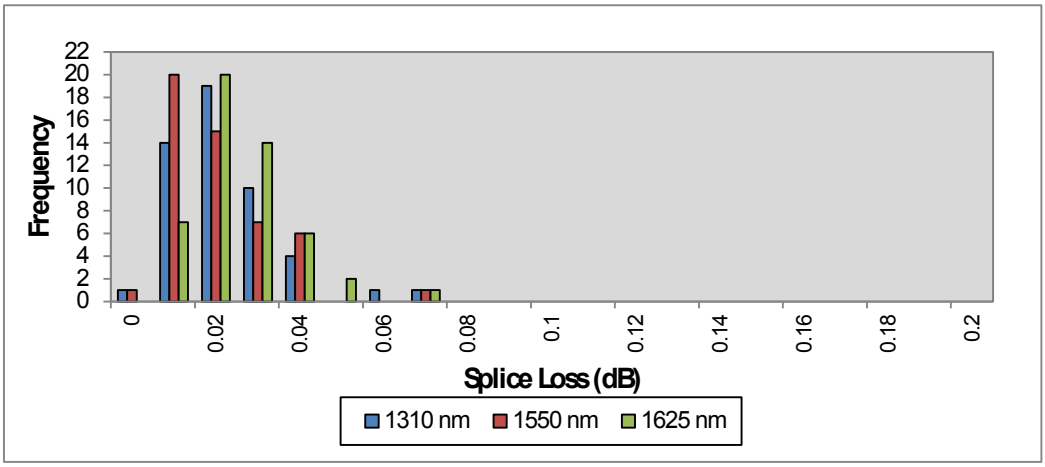
Table 1. List of Fiber Combinations and Sample Size

Fiber A	Fiber B	Quantity
Corning® SMF-28® Ultra Optical Fiber*	Corning® SMF-28® Ultra Optical Fiber*	50 splices*
Corning® SMF-28® Ultra Optical Fiber*	Corning® SMF-28e+® Optical Fiber*	30 splices*
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28® Ultra 200 Optical Fiber	28 splices
Corning® SMF-28® Ultra Optical Fiber	Corning® ClearCurve® LBL Optical Fiber	28 splices
Corning® SMF-28® Ultra Optical Fiber	Corning® ClearCurve® ZBL Optical Fiber	28 splices
Corning® SMF-28® Ultra Optical Fiber	Corning® LEAF® Optical Fiber	28 splices
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28® ULL Optical Fiber	28 splices
Corning® SMF-28® Ultra Optical Fiber	Corning® TXF™ Optical Fiber	28 splices

*Splicing data and results supplied by AFL

Results

Splicing Corning® SMF-28® Ultra optical fiber to Corning® SMF-28® Ultra optical fiber

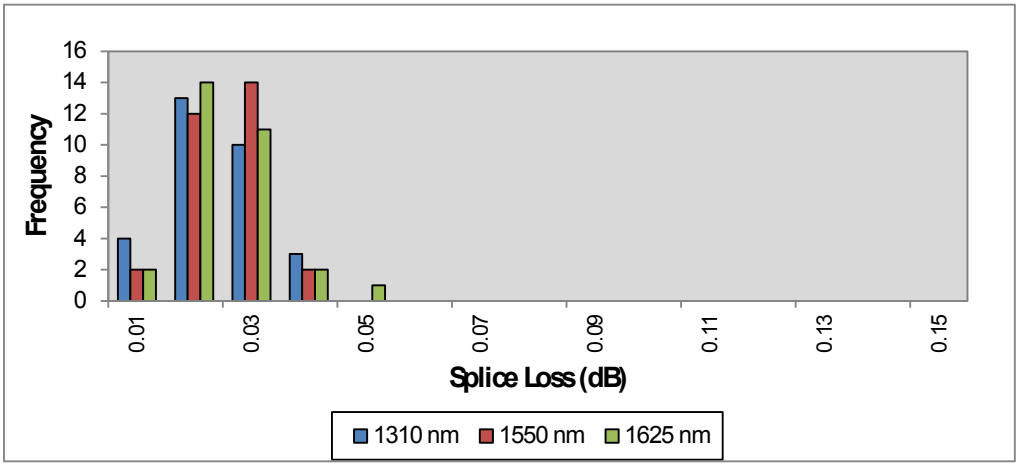


Splicer Type: FSM-70S	
Splicer Settings	
Program	SM-SM Mode 10
Cleave Limit	1.5°
Loss Limit	0.20 dB
Arc Power	STANDARD
Arc Time	2000 ms
Cleaning Arc	180 ms

Fiber A	Fiber B	Wavelength (nm)	Spec (dB)*	Mean (dB)	Standard Deviation	Maximum (dB)
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28® Ultra Optical Fiber	1310	Mean ≤ 0.10	0.02	0.013	0.07
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28® Ultra Optical Fiber	1550	Mean ≤ 0.10	0.02	0.012	0.07
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28® Ultra Optical Fiber	1625	Mean ≤ 0.10	0.03	0.012	0.07

*Summarized results provided by AFL and meet Telcordia GR-20 requirements, mean splice loss of a group to be ≤ 0.10 dB

Splicing Corning® SMF-28® Ultra optical fiber to Corning® SMF-28e+® optical fiber

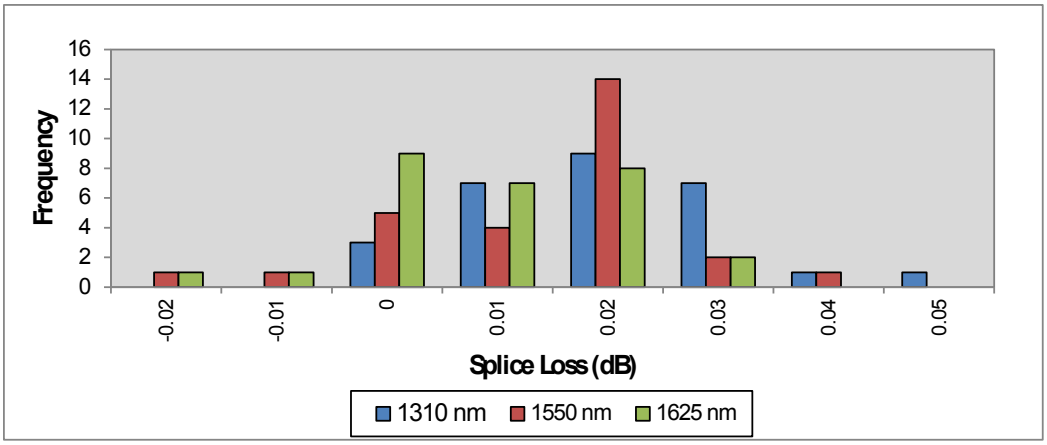


Splicer Type: FSM-70S	
Splicer Settings	
Program	SM-SM Mode 10
Cleave Limit	1.5°
Loss Limit	0.20 dB
Arc Power	STANDARD
Arc Time	2000 ms
Cleaning Arc	180 ms

Fiber A	Fiber B	Wavelength (nm)	Spec (dB)*	Mean (dB)	Standard Deviation	Maximum (dB)
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28e+® Optical Fiber	1310	Mean ≤ 0.10	0.02	0.008	0.04
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28®e+ Optical Fiber	1550	Mean ≤ 0.10	0.02	0.007	0.04
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28®e+ Optical Fiber	1625	Mean ≤ 0.10	0.02	0.008	0.04

*Summarized results provided by AFL and meet Telcordia GR-20 requirements, mean splice loss of a group to be ≤ 0.10 dB

Splicing Corning® SMF-28® Ultra optical fiber to Corning® SMF-28® Ultra 200 optical fiber

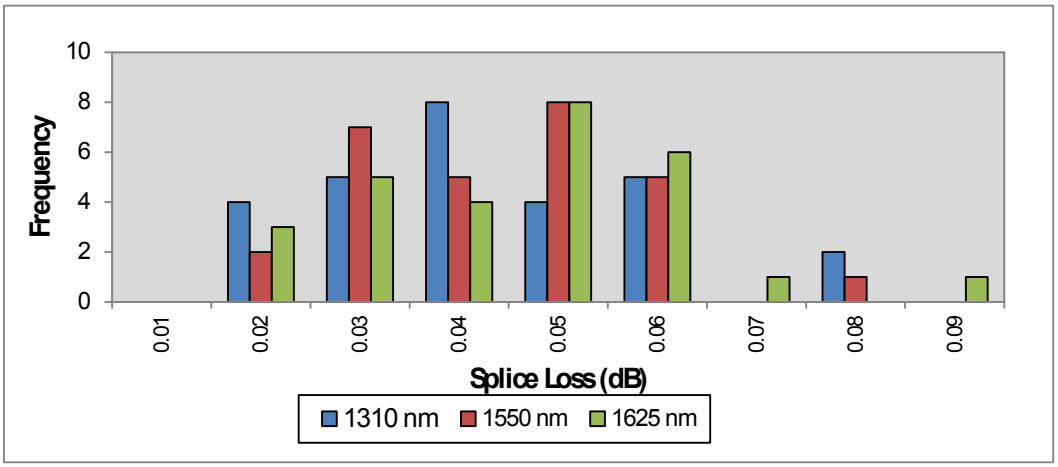


Splicer Type: FSM-70S	
Splicer Settings	
Program	SM-SM Mode 10
Cleave Limit	1.5°
Loss Limit	0.20 dB
Arc Power	STANDARD
Arc Time	2000 ms
Cleaning Arc	180 ms

Fiber A	Fiber B	Wavelength (nm)	Spec (dB)*	Mean (dB)	Standard Deviation	Maximum (dB)
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28® Ultra 200 Optical Fiber	1310	Mean ≤ 0.10	0.02	0.012	0.05
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28® Ultra 200 Optical Fiber	1550	Mean ≤ 0.10	0.01	0.012	0.04
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28® Ultra 200 Optical Fiber	1625	Mean ≤ 0.10	0.01	0.011	0.03

*Summarized results meet Telcordia GR-20 requirements, mean splice loss of a group to be ≤ 0.10 dB

Splicing Corning® SMF-28® Ultra optical fiber to Corning® ClearCurve® LBL optical fiber

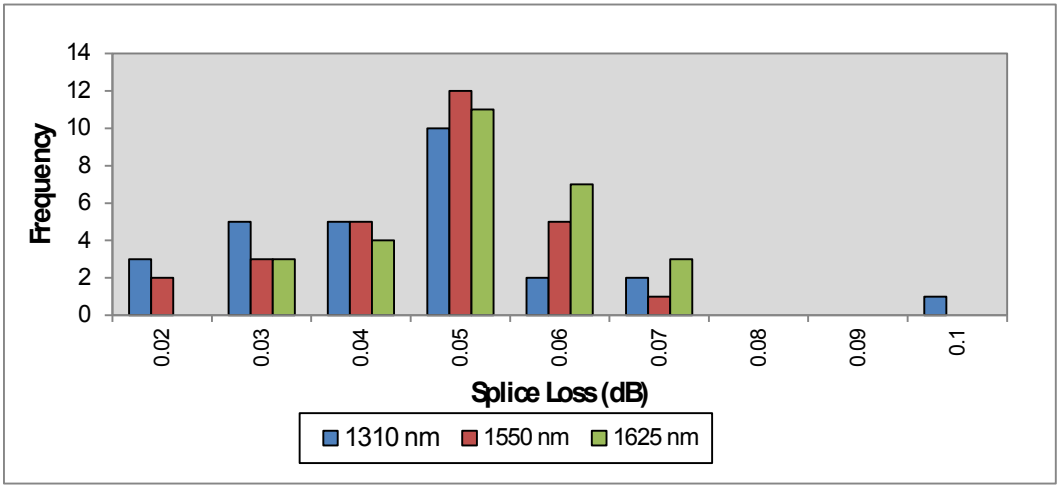


Splicer Type: FSM-70S	
Splicer Settings	
Program	SM-SM Mode 10
Cleave Limit	1.5°
Loss Limit	0.20 dB
Arc Power	STANDARD
Arc Time	2000 ms
Cleaning Arc	180 ms

Fiber A	Fiber B	Wavelength (nm)	Spec (dB)*	Mean (dB)	Standard Deviation	Maximum (dB)
Corning® SMF-28® Ultra Optical Fiber	Corning® ClearCurve® LBL Optical Fiber	1310	Mean ≤ 0.10	0.04	0.016	0.08
Corning® SMF-28® Ultra Optical Fiber	Corning® ClearCurve® LBL Optical Fiber	1550	Mean ≤ 0.10	0.04	0.015	0.08
Corning® SMF-28® Ultra Optical Fiber	Corning® ClearCurve® LBL Optical Fiber	1625	Mean ≤ 0.10	0.04	0.016	0.09

*Summarized results meet Telcordia GR-20 requirements, mean splice loss of a group to be ≤ 0.10 dB

Splicing Corning® SMF-28® Ultra optical fiber to Corning® ClearCurve® ZBL optical fiber

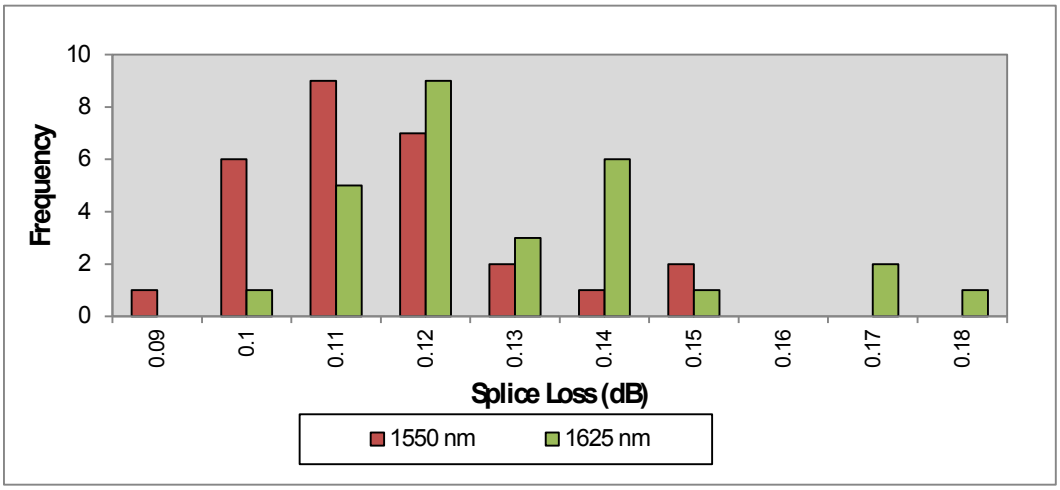


Splicer Type: FSM-70S	
Splicer Settings	
Program	SM-SM Mode 10
Cleave Limit	1.5°
Loss Limit	0.20 dB
Arc Power	STANDARD
Arc Time	2000 ms
Cleaning Arc	180 ms

Fiber A	Fiber B	Wavelength (nm)	Spec (dB)*	Mean (dB)	Standard Deviation	Maximum (dB)
Corning® SMF-28® Ultra Optical Fiber	Corning® ClearCurve® ZBL Optical Fiber	1310	Mean ≤ 0.10	0.04	0.018	0.10
Corning® SMF-28® Ultra Optical Fiber	Corning® ClearCurve® ZBL Optical Fiber	1550	Mean ≤ 0.10	0.04	0.013	0.07
Corning® SMF-28® Ultra Optical Fiber	Corning® ClearCurve® ZBL Optical Fiber	1625	Mean ≤ 0.10	0.05	0.013	0.07

*Summarized results meet Telcordia GR-20 requirements, mean splice loss of a group to be ≤ 0.10 dB

Splicing Corning® SMF-28® Ultra optical fiber to Corning® LEAF® optical fiber

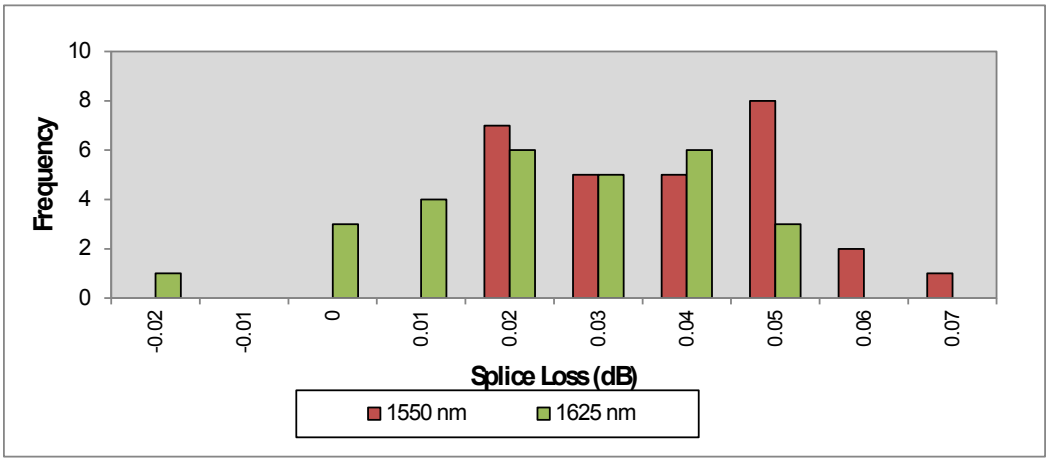


Splicer Type: FSM-70S	
Splicer Settings	
Program	SM-SM Mode 10
Cleave Limit	1.5°
Loss Limit	0.20 dB
Arc Power	STANDARD
Arc Time	2000 ms
Cleaning Arc	180 ms

Fiber A	Fiber B	Wavelength (nm)	Mean (dB)	Standard Deviation	Maximum (dB)
Corning® SMF-28® Ultra Optical Fiber	Corning® LEAF® Optical Fiber	1550	0.11	0.015	0.15
Corning® SMF-28® Ultra Optical Fiber	Corning® LEAF® Optical Fiber	1625	0.13	0.020	0.18

*Splice loss as per Telcordia GR-20 does not apply since this is a dissimilar fiber splice

Splicing Corning® SMF-28® Ultra optical fiber to Corning® SMF-28® ULL optical fiber

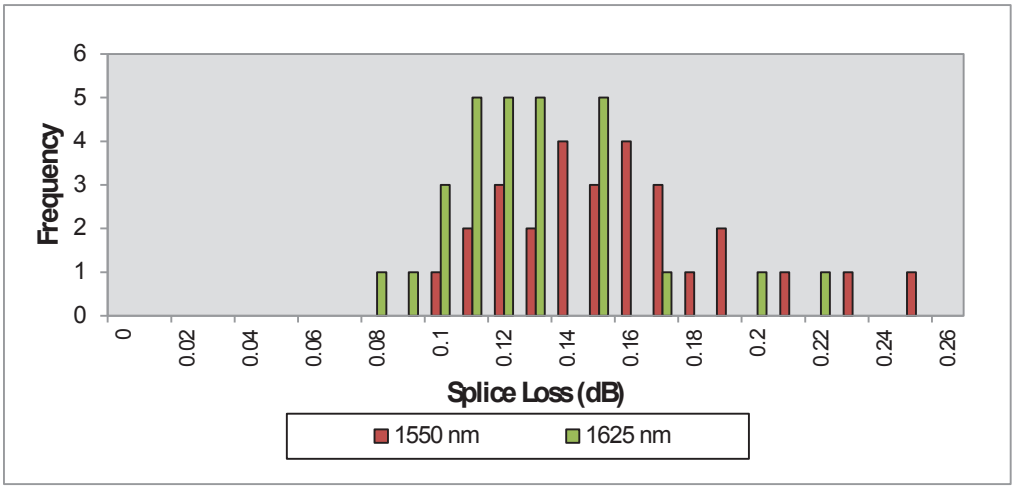


Splicer Type: FSM-70S	
Splicer Settings	
Program	SM-SM Mode 10
Cleave Limit	1.5°
Loss Limit	0.20 dB
Arc Power	STANDARD
Arc Time	2000 ms
Cleaning Arc	180 ms

Fiber A	Fiber B	Wavelength (nm)	Mean (dB)	Standard Deviation	Maximum (dB)
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28® ULL Optical Fiber	1550	0.03	0.015	0.07
Corning® SMF-28® Ultra Optical Fiber	Corning® SMF-28® ULL Optical Fiber	1625	0.02	0.017	0.05

*Splice loss as per Telcordia GR-20 does not apply since this is a dissimilar fiber splice

Splicing Corning® SMF-28® Ultra optical fiber to Corning® TXF™ optical fiber



Splicer Type: FSM-70S	
Splicer Settings	
Program	SM-SM Mode 10
Cleave Limit	1.5°
Loss Limit	0.20 dB
Arc Power	STANDARD
Arc Time	2000 ms
Cleaning Arc	180 ms

Fiber A	Fiber B	Wavelength (nm)	Mean (dB)	Standard Deviation	Maximum (dB)
Corning® SMF-28® Ultra Optical Fiber	Corning® TXF™ Optical Fiber	1550	0.15	0.036	0.25
Corning® SMF-28® Ultra Optical Fiber	Corning® TXF™ Optical Fiber	1625	0.12	0.032	0.22

*Splice loss as per Telcordia GR-20 does not apply since this is a dissimilar fiber splice

Visual Appearance During Fusion Splicing

A faint fusion line can be detected when the completed splice is visually inspected using the high magnification imaging system associated with a fusion splicer. Figures 1 and 2 are images of typical homogenous and heterogeneous fiber splices. The faint fusion line associated with the homogenous splice and the black and white lines associated with the heterogeneous splice are both a result of small refractive index differences created by the fusing process that are detectable by a splicer's imaging system. These lines may confuse the splicer's assessment algorithm, but the lines are not an indication of a poor splice. Splices with these faint fusion lines consistently pass the splicer's strength proof test and do not represent any functional concern.

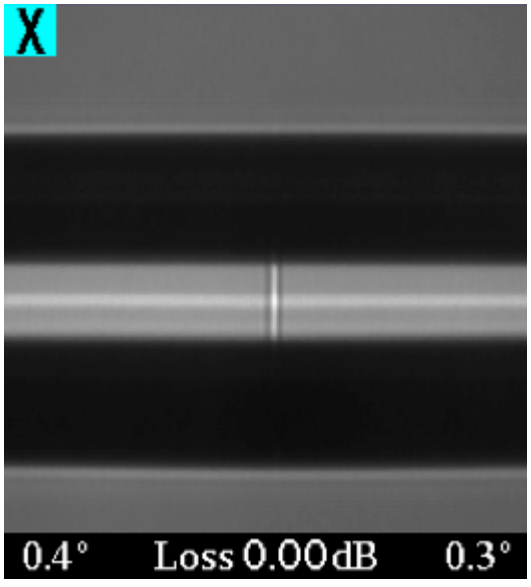


Figure 1. Homogeneous Splice

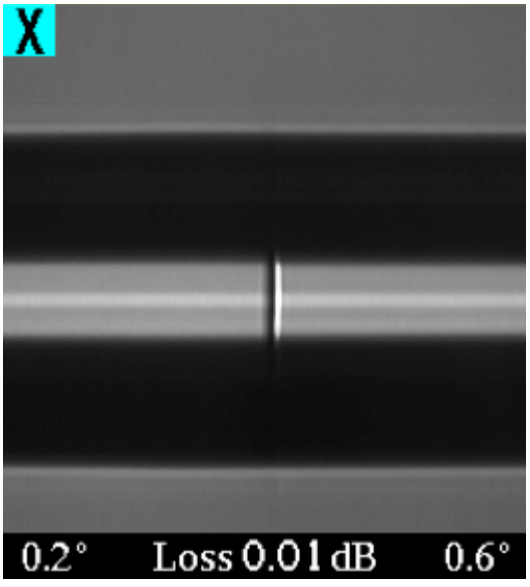


Figure 2. Heterogeneous Splice

Conclusion

Corning has completed a fusion splicing study for SMF-28 Ultra fiber using a commercially available active core alignment fusion splicer. A standard factory program was used to simulate field measurements. The results from this report confirm that SMF-28 Ultra fiber can be readily spliced to a variety of optical fiber types while maintaining low splice loss performance.

Heterogeneous fiber splices result in a broader unidirectional OTDR loss distribution as compared to homogeneous fiber splices. This emphasizes the importance of conducting bidirectional OTDR loss measurements to accurately measure the true splice loss.

Corning Incorporated
www.corning.com/opticalfiber

One Riverfront Plaza
Corning, New York
USA

Phone: (607)248-2000
Email: cofic@corning.com