White Paper

Sterlite Tech

Bend insensitive 200 micron optical fiber

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Issued
Feb 2015
Supercedes
September 2013

Abstract

Deployment of optical fiber cable in limited space and in tight bend conditions demands reduced diameter optical fiber and cable with bend insensitive fiber. To address this need, optical fiber with 200 micron outer coating diameter instead of 250 micron for conventional fiber has been developed. This white paper outlines various advantages of 200 micron fiber and its backward compatibility with conventional fiber.

Keywords
Optical fiber, 200 micron coating diameter, Bend insensitive fiber

Optical fiber is used in all modern optical communications including long-haul, regional, access, and FTTX networks. An optical fiber is made up of three layers, namely, core, cladding, and coating. Light is guided down the center of the fiber called the “core”. The core is surrounded by an optical material called the “cladding” that contains the light in the core using an optical phenomenon called “total internal reflection.” The fiber is coated by a buffer layer that protects it from moisture and physical damage. The buffer or “coating” is what one strips off the fiber for termination or splicing. More protection is provided by the cable which has the fibers and strength members inside an outer protective covering called a “jacket” or a “sheath.”

The fiber coating is made of a UV curable polymer called acrylate, which acts to protect the inner glass. Dual layered coating structures are generally applied, which use a low-modulus inner or buffer layer to cushion the fiber surrounded by a high-modulus outer coating to increase the flexural rigidity and distribute the lateral external forces.

Glass cladding and outer coating diameter are standardized to 125 μm and 250 μm respectively in various international standards and recommendations. Standardization of these two critical dimensions of silica glass optical fiber has ensured-compatibility between optical networks across the globe. Currently, single mode optical fiber with a reduced 200 μm coating diameter and 125 μm cladding diameter is commercially available. The 125 μm cladding diameter ensures backward compatibility with existing optical network. Fig. 1 shows a comparison between 250 μm and 200 μm coated fiber. This reduced diameter optical fiber opens up options for producing cable with more compact designs allowing more penetration depth in access and FTTX networks.

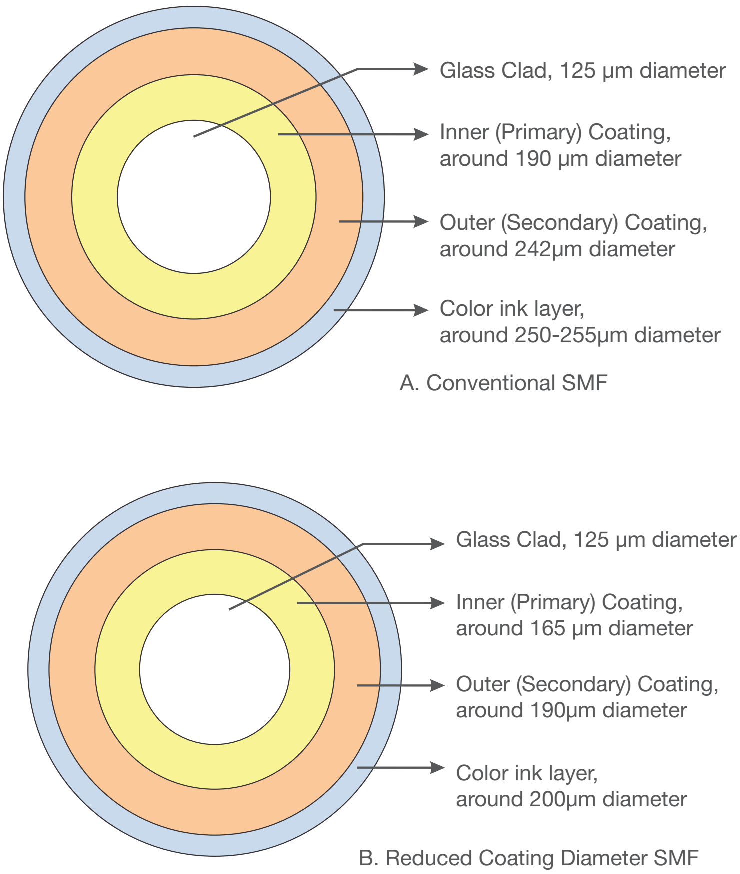


Figure 1: Schematic Cross sectional view of SMF (not to scale)

Challenges in cable deployment in optical networks

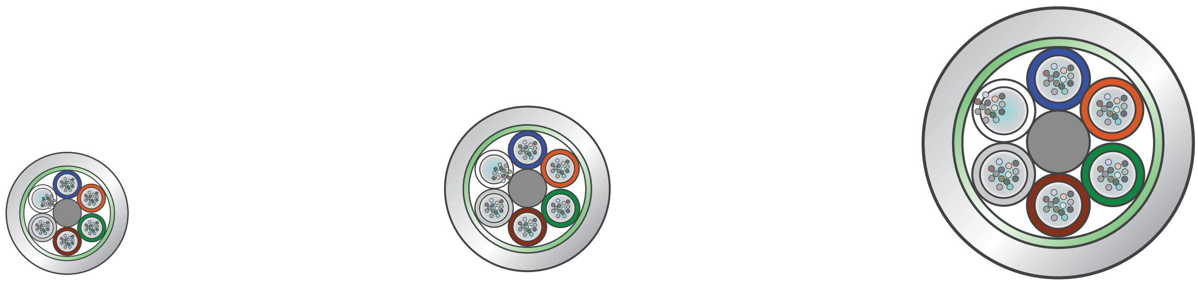
There are two major challenges in cable deployment in high capacity optical networks – limited space in distribution network and tighter bends in subscriber loop. To provide service to large number of subscribers, high fiber count optical fiber cables which can carry large volume of information is necessary in distribution network. Currently optical fiber cable is available with over 1000 fibers in a single cable.

Although high fiber count cable is a solution to handle large volume of information, this option is not always suitable due to limited space in installed ducts as higher fiber counts generally increase the cable diameter. Installation of new ducts is an expensive & time consuming operation due to the large amount of civil work needed, and the need to get right of way approval from the government & other local bodies. At present, successful penetration of optical fibers into the local distribution networks depends on the development of small, flexible, lightweight and cost effective cables. In addition, cable blowing distances can be vastly increased using smaller and lightweight cables reducing deployment costs Therefore, reduced diameter cables called 'micro cables' have become popular during duct and cable installation. To increase fiber count further in micro cables and to reduce cable diameter further such that micro-ducts can be used, a compact cable design is necessary. Compact cable design can be achieved by increasing fiber packing density, and reducing size of the cable elements and fiber. Tighter packing density and reduced size cable elements need fiber with less micro-bend sensitivity. Additionally, fiber with improved macro-bend sensitivity is essential to limit increase in optical power loss due to tighter bends in subscriber loop. Bend sensitivity improved ITU-T G.657 category SMF with reduced coating diameter is therefore the solution for compact cable design.

A significant improvement in fiber density in optical fiber cables can be achieved by using bend insensitive 200 micron optical fibers. Figure 2 illustrates how compact cable design is achieved with 200 micron fiber. Diameter of a 72 fiber cable with 250μm fiber is around 13.5 mm. In Micro cables, the diameter was reduced to around 7.2 mm for 96 fibers. With 200 micron fiber, 144 fiber cable can be produced with 6.8 mm outer cable diameter. A 38% reduction in fiber cross-sectional area enables higher fiber count cables with smaller cable outer diameter. In the 144 fiber micro cable, 24 fibers instead of 12 can be placed in a similarly sized loose tube. Although this type of design has higher packing density, it can result in higher optical loss due to micro-bending effect. Use of bend improved ITU-T G.657 category fibers with micro-bend resistant coating reduces micro-bend loss and helps to achieve targeted cable attenuation.

nm, while at 1550 nm, the mean splice loss and SD are 0.022 dB and 0.017 dB respectively. According to ITU-T G.982 recommendation by extrapolating from the Gaussian fit, the worse case (mean + 3 x SD) splice losses are 0.07 dB and 0.073 dB at 1310 and 1550 nm respectively, which less than the ITU requirement of maximum splice loss of 0.1 dB [2].

Similarly, 200 micron fiber has little impact on single fiber connectors as fiber is up- jacketed before connecterization. However, use of 200 micron fiber in ribbon structure is currently under study. Outer coating diameter decides spacing between two adjacent fibers in a ribbon structure and thus effectiveness of mass fusion splicing. Therefore, if splicing to



Micro cable with 144 fiber (200 micron) with ~6.8 mm diameter

Micro cable with 96 fiber (250 micron) with ~7.2 mm diameter

Conventional cable with 72 fiber (250 micron) with ~13.5 mm diameter

Figure 2: Schematic cross sectional view of various cable designs

In IEC 60793-2-50 (Edition 4) single mode fiber specification, 200 micron fiber was included as an alternative coating diameter option [1]. As shown in Fig. 1, in the 200 micron fiber, diameter of the coating layers are reduced in comparison to conventional fiber whereas diameter and other characteristics of glass cladding remain same. In the field, 200 micron fiber works well with the existing tools and practices during stripping and splicing. Once coating is stripped out, cladding diameter is 125 micron which is same as conventional 250 micron SMF; therefore cleaving and fusion splicing can be performed with the same tools. Figure 3 and 4 shows splice loss distribution of 200 micron v/s conventional SMF (Sterlite's MICRO BOW LITE™ vs BOW LITE™) at 1310 nm and 1550 nm respectively. The measured mean splice loss is 0.016 dB with standard deviation (SD) of 0.018 dB at 1310

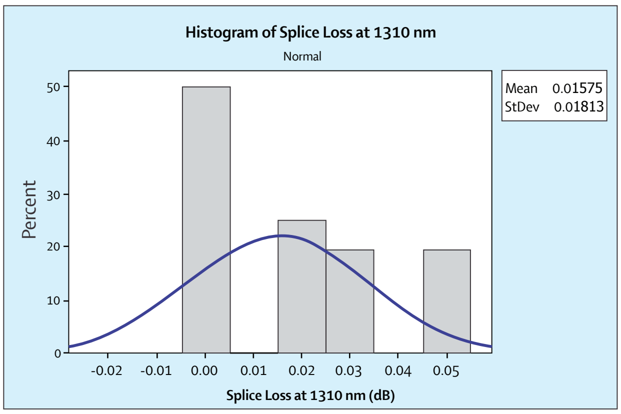


Figure 3: Splice loss between 200 micron and conventional SMF at 1310 nm

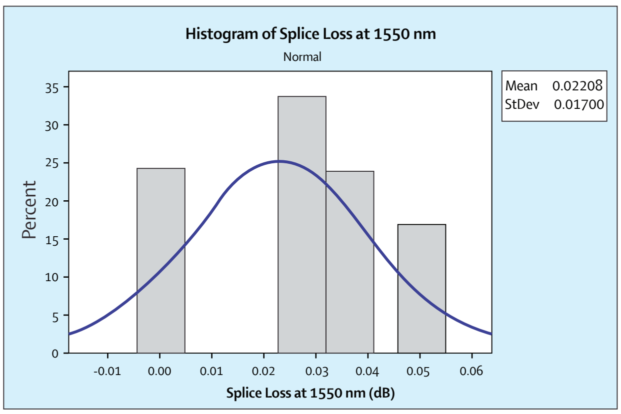


Figure 4: Splice loss between 200 micron and conventional SMF at 1550 nm

existing 250 micron ribbon cables is a requirement, the ribbon structure of 200 micron fiber with the spacing equal to 250 micron ribbon is needed.

Sterlite's 200 micron fiber are fully backward compatible with existing fibers, and other reliability parameters controlling fiber life time like proof-test level, dynamic fatigue (N_d), tensile strength of both un-aged & aged fibers, change in attenuation due to attenuation due to environmental aging etc meet the requirement of IEC 60793-2-50 standard.

Use of next generation coating provides the same reliability level even after reduction of coating diameter.

Conclusions

Bend improved single mode optical fiber with reduced coating diameter of 200 micron fiber is compatible with existing 250 micron fiber in optical networks and provides 38% lesser cross-section area allowing more compact micro cable designs. Sterlite's MICRO BOW-LITE™ and MICRO BOW-LITE™ (E) are 200 micron ITUT G.657.A1 and G.657.A2/B2 category fiber respectively and provide a novel and reliable solution to tighter bends and limited duct space frequently encountered in real-life network deployments.

References

1. IEC 60793-2-50 ed4.0, Optical fibers - Part 2-50: Product specifications - Sectional specification for class B single-mode fibers.

2. ITU-T G.982, Optical access networks to support services up to the ISDN primary rate or equivalent bit rates (1996).