Technical Note

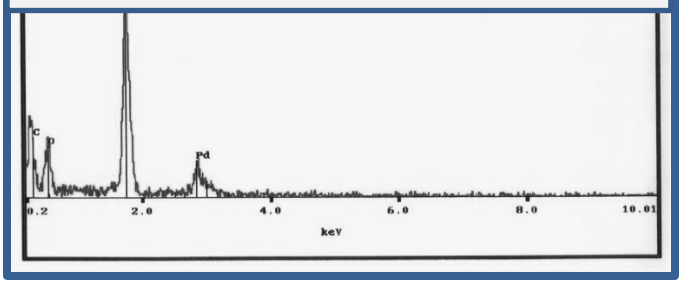
OFS Silicone Optical Fiber Coating

Optical fibers are made from pure silica glass with the addition of dopants. Silica has high tensile strength (greater than steel) and can operate at temperatures up to 1100°C. Despite their high strength, silica glass fibers require coatings to protect and maintain the strength of the glass during installation and operation when abrasion, bending and other stresses can cause fiber fatigue due to crack propagation. And despite silica's naturally high temperature resistance, the maximum operating temperature of the final product is dictated by the lowest temperature material used. Standard optical fibers use dual urethane acrylate coatings and are typically specified to +85°C, but many non-telecommunications applications such as avionics cables require operation at higher temperatures.

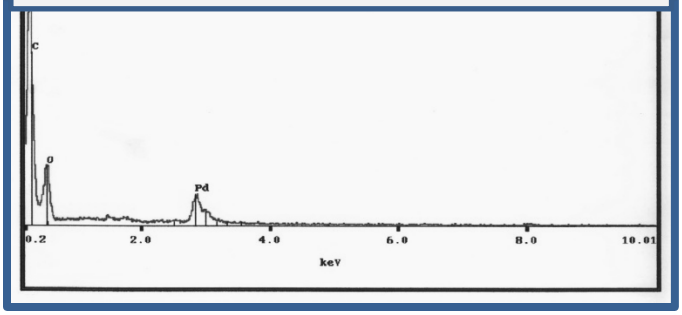
Silicone is one of the specialty coatings applied to optical fiber to enable higher temperature performance. Silicone is applied to a greater thickness than acrylate (78 - 162 µm on a 125 µm fiber) and generally has a thermoplastic buffer such as ETFE, PFA or FEP, applied over for abrasion resistance. Silicone materials are known for their use as protective coatings in various harsh environments. They impart low-temperature flexibility, as well as resistance to high temperature (-60 to 200°C) and humidity. In fiber optic cables, the low modulus of silicones and their rubbery nature provide a necessary cushion for the optical fiber against microbending. "Microbending" refers to deformation of the fiber axis on a small scale, typically on the order of microns up to a millimeter; it can result from external stresses or improper cable design, in turn causing leakage of the optical signal being transmitted. In a tight-buffer cable, the silicone not only cushions the fiber, but provides sufficient strength to anchor it securely within upbuffer and strength-member components. This limits the tendency for "pistoning" of the fiber within the cable. The silicone used in Flightlink™ and FlightGuide® products is chemically compatible for use as a coating either directly against the glass surface of the optical fiber or as a second coating atop a hermetic carbon layer. When used directly against the glass, silicone provides superior shielding against the corrosive effects of atmospheric moisture, in comparison with conventional urethane acrylate coatings. Additionally, while our silicone is not technically classified as flame retardant, silicones tend to provide a greater level of flame resistance in comparison with conventional urethane acrylate fiber coatings. In combination with flame-retardant upbuffers, strength-members, and jacketing materials, the silicone helps to satisfy the overall requirements of Flightlink™ and FlightGuide® cables for resistance to flammability. This was demonstrated by OFS FlightLink 62.5 passing the FAA FAR 25.869, 60° Burn Test.

There are many formulations of silicone some of which can leave an oily residue. The type of silicone OFS uses in avionics cables can strip easily with standard mechanical strip tools leaving little or no residue. Data below from EDX testing showed no trace of silicone after stripping. Additional testing has confirmed that termination of the stripped fibers can be accomplished using fiber-optic grade epoxy for connector attachment, with superior retention strength and resistance to pull force.

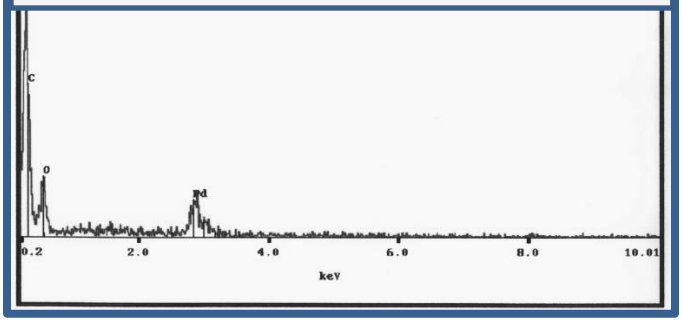
EDX Testing of Silicone Surface (Control)



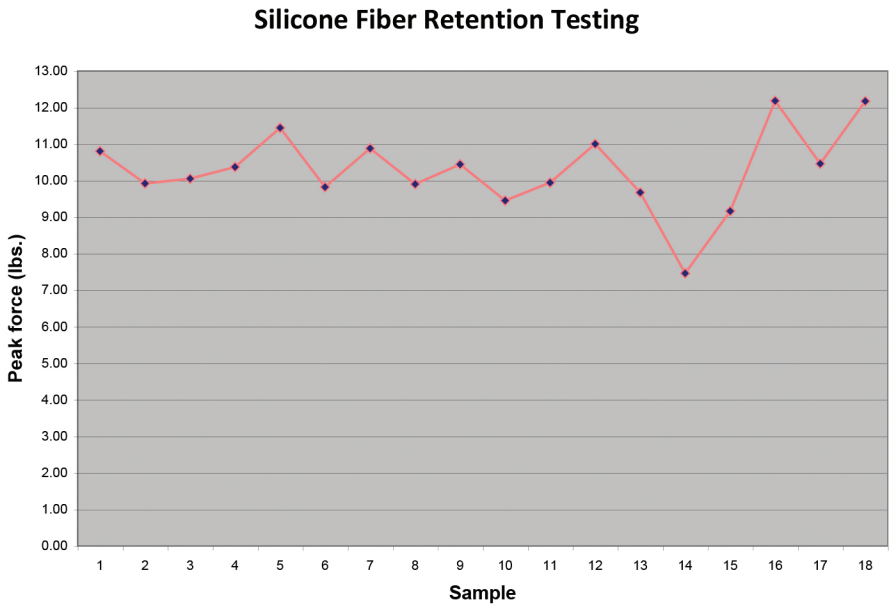
EDX testing of Control Fiber Surface (no Silicone)



EDX Testing of Fiber Surface After Mechanically Stripping Silicone (no wipe)



Connector retention testing results on silicone coated fiber is shown in the graph below. None of the samples tested pulled out of the connector, the fiber broke on each test.



AVG	10.28
MIN	7.46
MAX	12.18
STD.DEV.	1.10
MEDN	10.21

Silicone is just one of the many coating options offered by OFS Specialty Photonics. Other coatings options include standard dual layer acrylate, single acrylate, high temp acrylate, silicone/acrylate, polyimide, fluoroacrylate, and carbon.