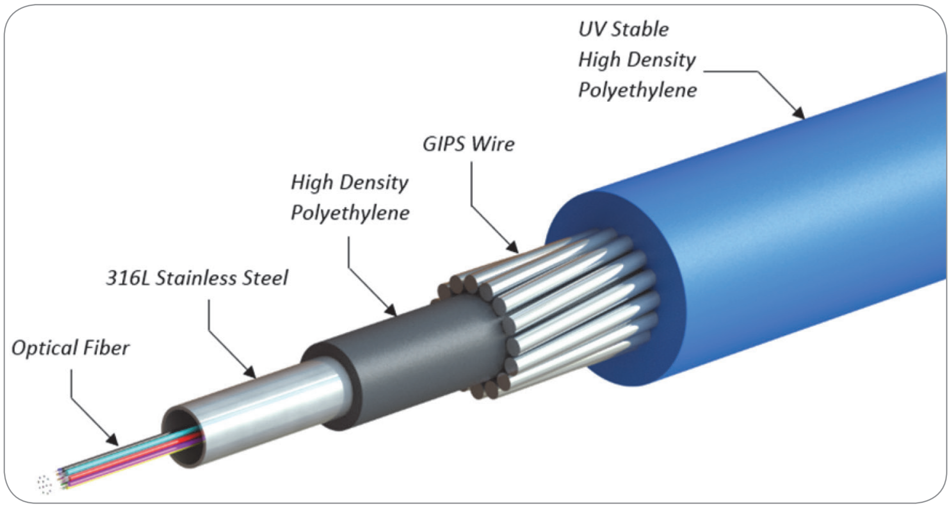
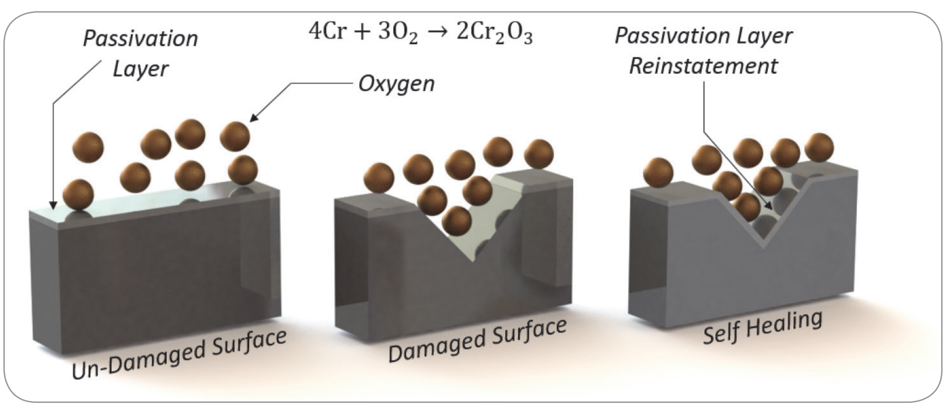
Fiber Optic Cable

Application Note AN-3002
Benefits of Stainless Steel Tubes in Subsea Optical Cables

Inside of many subsea umbilical cables, optical fiber data communications is needed to monitor fluid flow rate, pressure and temperature at a subsea wellhead. As deep-sea offshore deployments go further out, there is an increased physical burden on the supporting subsea power requirements and structures. In order to accommodate this demand subsea power umbilical combine larger power conductors with considerably larger tiebacks that subsequently increase the stress/strain as well as temperature. By monitoring with a Brillouin Optical Time Domain Analyzer (BOTDA), these heightened effects can be governed to not exceed the safe working design limits of the subsea umbilical cable. Optical component cables are rugged and built to last and that is largely due to the most vital component inside the cable construction—the component that hermetically seals out pressurized fluids and contaminants that could damage the fiber. This vital component is usually made of an austenitic stainless steel material and has a few benefits to highlight.



When the chromium content is increased to approximately 11 percent in an iron-chromium alloy, the resulting material is generally classified as a stainless steel. With that minimum quantity of chromium, a thin, protective, passive film forms spontaneously on the steel[1]. This happens when Chromium reacts with oxygen and produces chromium oxide which acts as a passivation barrier that prevents oxidation and corrosion, and heals the material from surface damage.



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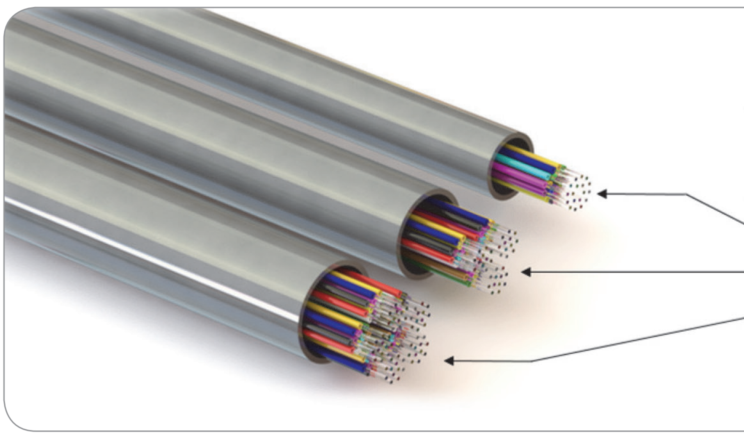
Benefits of Stainless Steel Tubes in Subsea Optical Cables (cont.)

Subsea umbilical cables are subjected to an environment high in chlorides (sea water) where galvanic corrosion can decrease operational life. Galvanic corrosion (also called "dissimilar metal corrosion" or wrongly "electrolysis") refers to corrosion damage induced when two dissimilar materials are coupled in an electrolyte. It occurs when two (or more) dissimilar metals are brought into electrical contact under water. When a galvanic couple forms, one of the metals in the couple becomes the anode and corrodes faster than it would by itself, while the other becomes the cathode and corrodes slower than it would alone[2]. A common primary means of strength in a subsea fiber optic cable is traditionally galvanized improved plow steel or GIPS wire. The electric anodic potential difference between steel wire (after the sacrificial zinc galvanization has been depleted) and the stainless steel fiber tube is less in comparison to that of copper which is an alternative fiber tube material type and steel wire where the electric potential difference is greater, thus having an elevated corrosion rate[3].

An important mechanical characteristic that comes into play in subsea optical cable design is material ductility. *Ductility* is most commonly defined as the ability of a metal to plastically deform easily upon application of a tensile force without breaking or fracturing. Cold working materials can decrease ductility but increase strength through strain hardening or grain dislocation. However, if cold working is induced to a point where the percent reduction in area is too high, then this can lead to a final material condition that is brittle and susceptible to fracture under loading. Umbilical cables have to be built to have a high tolerance to the harsh environment that a subsea umbilical cable endures during its operational life.

AFL manufactures stainless steel tubes that are ideal for applications where elevated exterior gas or liquid pressure is a factor. Additionally, patented methods are used by AFL to achieve an optimal window of strain-hardening that adds a balance of both adequate strength and ductile characteristics to the stainless steel tube component of a subsea umbilical cable. With superior mechanical performance and relatively small wall thickness (nominal 0.20 mm), tubes can be assembled with higher fiber counts enabling end users to monitor more assets.



Tube Size (mm)	Fiber Count	Weight (kg/km)
2.4	18	14.4
3.2	36	21.7
3.6	60	26.2

Fibers are shown as 250 micron nominal diameter

[1] Marks Standard Handbook for Mechanical Engineers, 11th Edition, 6-29.

[2] https://www.nace.org/Corrosion-Central/Corrosion-101/Galvanic-Corrosion/

[3] http://www.engineersedge.com/galvanic_capatability.htm