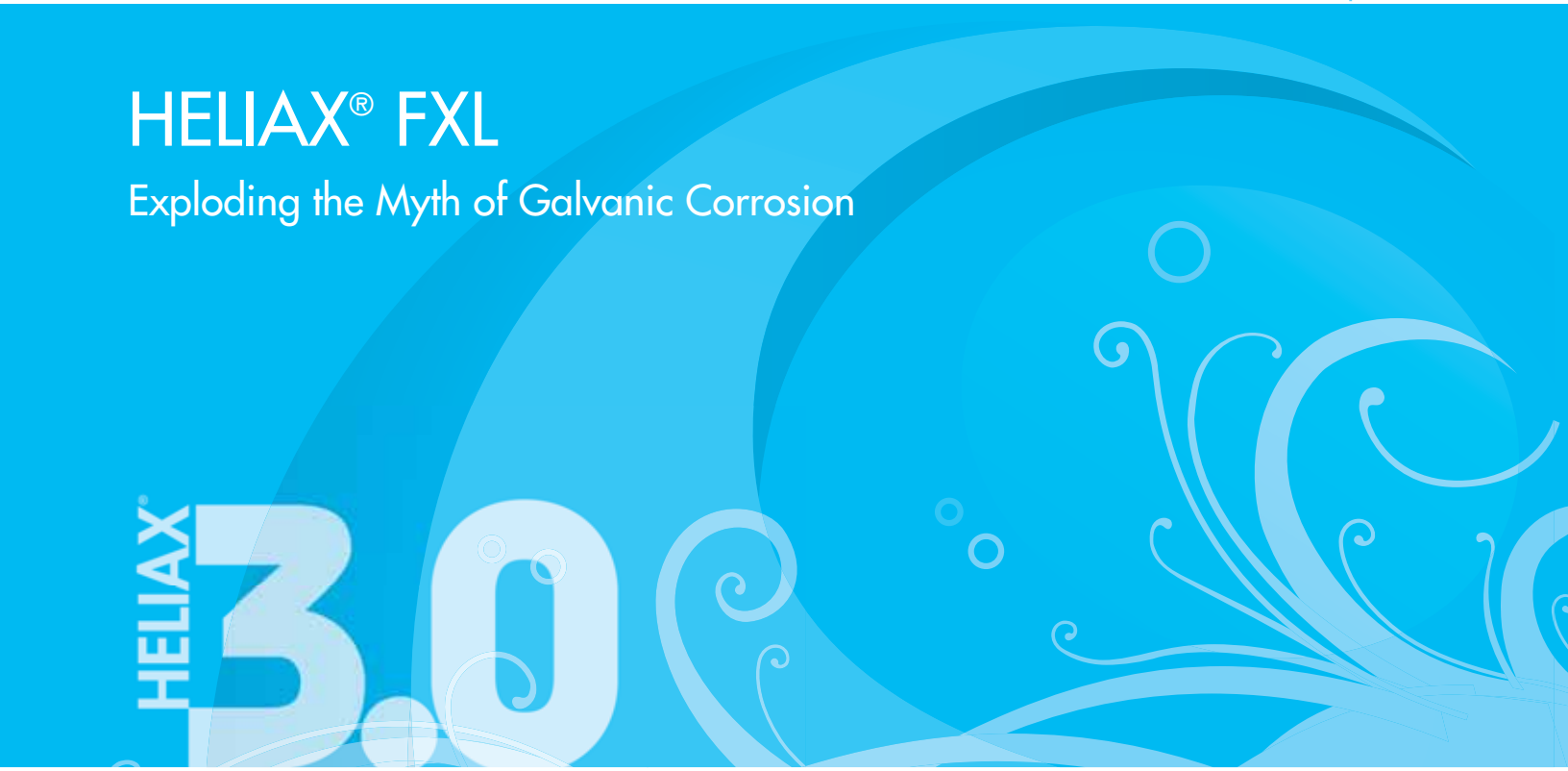
COMMSCOPE®

White Paper

HELIAX® FXL

Exploding the Myth of Galvanic Corrosion



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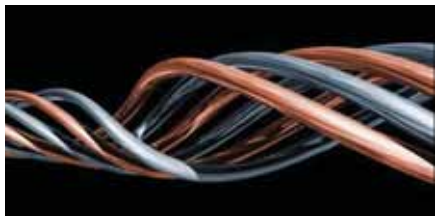

Why HELIAX FXL Smoothwall Cable?

By incorporating aluminum into the cable design, as opposed to any other metal, HELIAX FXL provides key unique benefits:

- Proven: 90% of high voltage transmission lines use aluminum conductors and 99% of all CATV cables are aluminum.
- Lightweight and Forms to Application: Aluminum is flexible and is one-third the weight of copper.
- Weatherproof: Made possible by HELIAX FXL's triple-bonded construction and filled center using patented microcell foaming technology.

Since its introduction in 2001, one of the persistent myths surrounding HELIAX FXL cable from CommScope is that, due to its use of aluminum and copper, it is more susceptible to corrosion than other transmission line cables. However, this misconception regarding HELIAX FXL overlooks one very critical fact: without moisture there can be no corrosion1. This is where HELIAX FXL has distinguished itself from other transmission line cables.

HELIAX FXL uses a unique triple-bonded design that prevents moisture ingress, especially at the connector interface where corrosion is most likely to begin. The ability of HELIAX FXL to eliminate corrosion under some of the harshest environmental conditions has been well-documented with over 100 million feet deployed with major wireless operators around the globe.

As a result, HELIAX FXL enables operators to eliminate a major cause of cable failure—corrosion, while retaining all the advantages provided by the use of its dissimilar metals.

Growing Use of Dissimilar Metals in RF Transmission Lines

Historically, electrical engineers have long recognized the value in the pairing of certain dissimilar metals in the design of transmission cable. As early as 1977, copper-clad aluminum (CCA) was deployed as the preferred transmission line for the burgeoning CATV industry. More recently, wireless operators have embraced CCA as the material of choice for high frequency coaxial applications such as power cables.

As the demands grow for lighter, more flexible, lower loss RF transmission cables, the potential of an all-copper design is limited. The pairing of dissimilar materials holds the key to achieving the characteristics necessary to help operators continue to increase performance while holding down costs.

CommScope Introduces HELIAX® FXL

CommScope® began leveraging its experience with dissimilar metals in the late 1990s. By 2001, engineers had successfully produced a 50-ohm transmission line cable, HELIAX FXL, using an all copper center conductor and lightweight aluminum outer conductor.

HELIAX® FXL offers several advantages making it attractive for operators looking to minimize CAPEX and OPEX while maintaining excellent electric performance. Compared to its corrugated all-copper competitive cable, the new HELIAX FXL smoothwall cable:

- Offers up to 10% better attenuation
- Delivers 70% better stretch resistance
- Provides 200% better crush resistance
- Weighs as much as 30% less
- Has reduced scrap value—minimizing the risk of theft.

One of the lingering myths that persist regarding HELIAX FXL is that it is more susceptible to galvanic corrosion.

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Exploding the Myth of Galvanic Corrosion

The key to preventing galvanic corrosion is the ability to eliminate the presence of moisture in the cable. HELIAX FXL prevents water ingress by employing a unique triple-bonded design.

Galvanic Corrosion

Galvanic corrosion occurs when dissimilar metals are connected in the presence of an electrolyte such as water. During the process of galvanic corrosion, electrons flow between the two metals, forming a galvanic couple. In any galvanic couple, one metal is more chemically active than the other one. The flow of electrons to the more active metal causes it to corrode faster than it would by itself while the less active metal will corrode slower.

A metal's activity can be expressed in a table, known as a Galvanic Series. A Galvanic Series lists various metals, from most noble (least likely to corrode) to least noble (most likely to corrode). The table in *Figure 1* indicates the reactivity of various metals in the presence of rainwater.

The nature and aggressiveness of the environment can also impact the severity of galvanic corrosion[2]. For example, acid rain, common in densely populated urban areas, provides increased conductivity that can greatly accelerate the process.

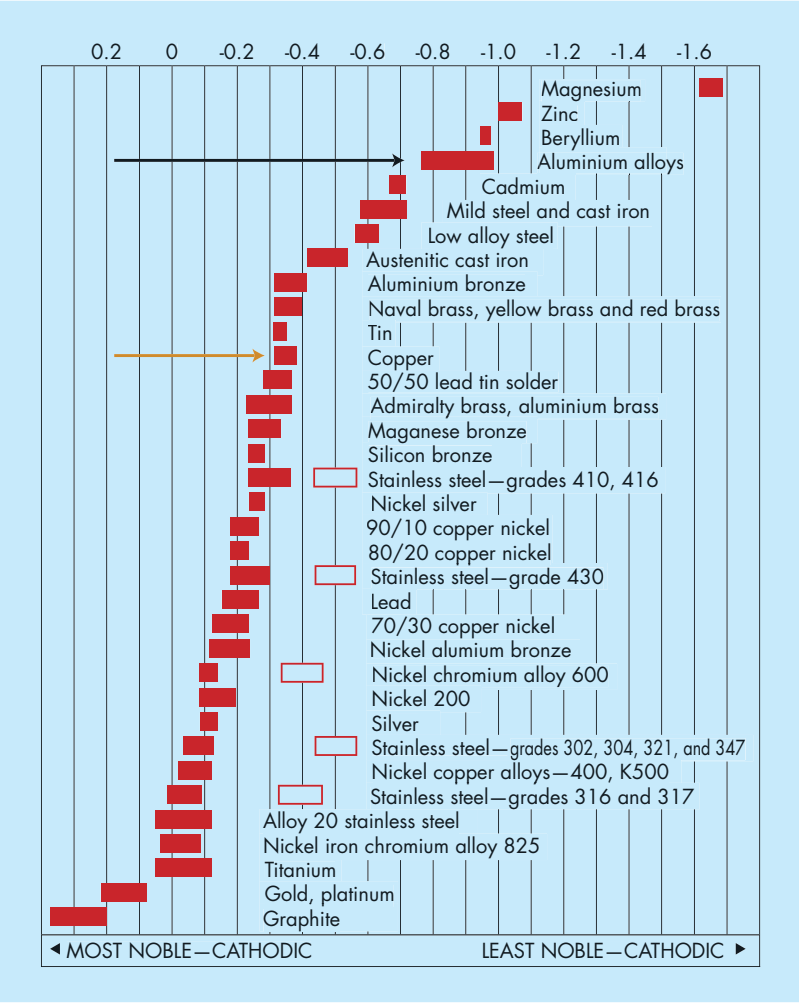

Figure 1: Galvanic Corrosion Chart

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The phenomenon known as galvanic corrosion occurs when dissimilar metals are connected in the presence of an electrolyte such as water.

Electrolyte Issues in the Wireless Industry
In wireless networks, a serious risk to network performance is cable failure due to moisture in the cable. Once inside, moisture has the potential to travel down the length of the cable through the dielectric and the inner conductor.

This process, however, assumes the presence of an electrolyte; and this is where the myth regarding HELIAX FXL's susceptibility to corrosion breaks down. By completely blocking moisture from entering the cable, HELIAX FXL eliminates any chance of corrosion.

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Blocking Moisture at the Source

Using a unique triple-bonded smoothwall design (Figure 2), HELIAX FXL eliminates galvanic corrosion by not only ensuring moisture cannot enter at the connector interface but by preventing it from gaining access anywhere along the length of the cable.

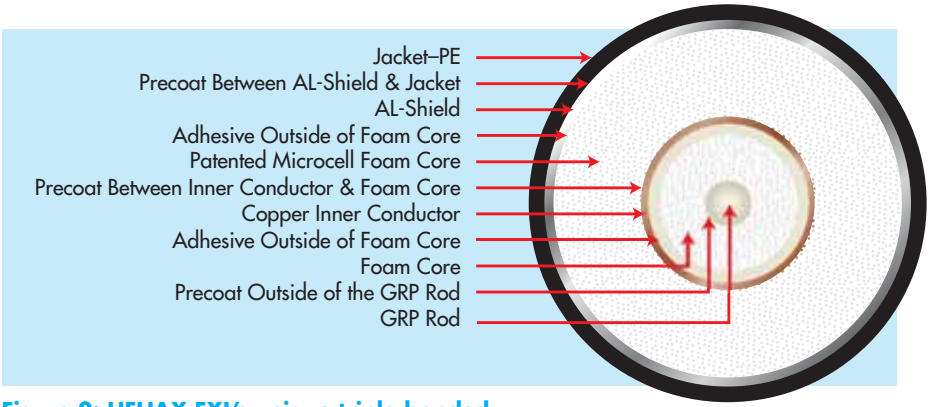

Figure 2: HELIAX FXL's unique triple-bonded smoothwall design

The weatherproof outer jacket, engineered with black polyethylene (PE) is physically bonded to a smoothwall aluminum shielding layer. The smoothwall shielding shares a physical bond with the closed microcell foam dielectric.

Closed cell foam prevents water from moving through the cable. If there is a water breach at the connector, the water is stopped and the cable can be re-cut a short distance in and be reconnected. The cable's copper center conductor is embedded in the heart of the dielectric and is completely filled, unlike standard coaxial cable which typically utilizes a hollow tube inner conductor. The result is a complete surface-to-surface bond that eliminates any path for water to travel along. Under magnification the difference between HELIAX FXL (Figure 3), and corrugated cable (Figure 4) becomes apparent.

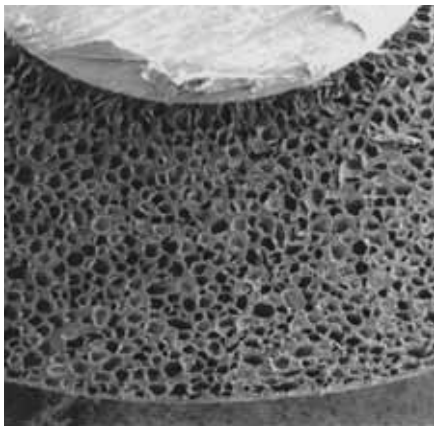

Figure 3: HELIAX FXL cable provides a Closed Micro-Cell Dielectric which prevents water ingress-resulting in a lower life cycle cost.

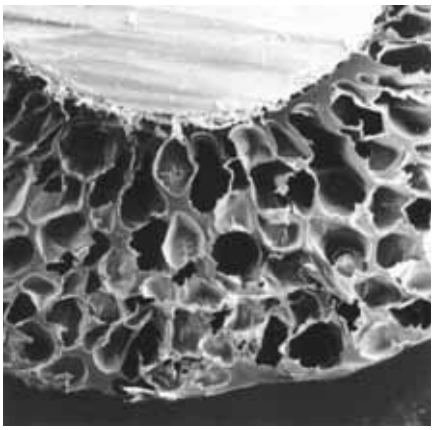

Figure 4: Corrugated cables' foam dielectric cells are typically much larger, and can absorb moisture.

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Proven Quality—Backed by a 10-Year Warranty

FXL cable products are subjected to extreme testing to ensure superior quality. Once the connectors are installed properly, water migration is not an issue. All FXL cables are backed by a 10-year warranty—but their expected lifespan is far longer.

Field Data Confirms Claims

Ultimately any claims regarding the ability of HELIAX FXL to prevent corrosion are either proven or disproven in the field. Thus far, field results such as the following leave no question.

In 2004, CommScope presented test data and anecdotal evidence of its smoothwall cable technology to engineers of a prominent wireless OEM. Reluctant to accept the claims of a cable that had never experienced failure due to moisture, the OEM requested a series of extreme environmental tests. The trials were designed jointly by CommScope and the OEM for the singular purpose of trying to cause the cable to fail. For that reason, no secondary waterproofing was used and the cable assemblies were connected under the same harsh conditions to which they were subjected. The tests included Extreme Thermal Cycling and Icing, Extreme Rain, and Extreme Thermal Stress Cycling.

After weeks of simulating the worst environmental conditions on earth, HELIAX FXL cable survived with unsurpassed quality and performance. (See **Extreme Testing Technical Article**)

In total, major wireless operators around the globe have deployed over 100 million feet of HELIAX FXL cable since 2001.

CommScope Delivers Confidence

The pressure is increasing for operators to deliver better spectrum efficiency while reducing both OPEX and CAPEX costs. This is true for all aspects of the backhaul network, including RF transmission cable. Operators, in turn, are looking to companies such as CommScope to develop innovative and dependable solutions.

Given the design limitations inherent in an all-copper solution, the use of dissimilar metals will continue to play an important role in the success of the backhaul network. Engineers at CommScope have long recognized this. HELIAX FXL cable represents a long history that includes critical insight into RF cable design; hands-on experience with the use of dissimilar metals; and applications in the field that continue to yield impressive results.

[1] "Handbook of Aluminum, Second Edition", Aluminum Company of Canada, pg 19

[2] "Corrosion of Metals and Alloys Refs."—Mars G. Fontana and Denny A. Jones

[3] United States Geological Survey, http://ga.water.usgs.gov/edu/watercyclecondensation.html

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