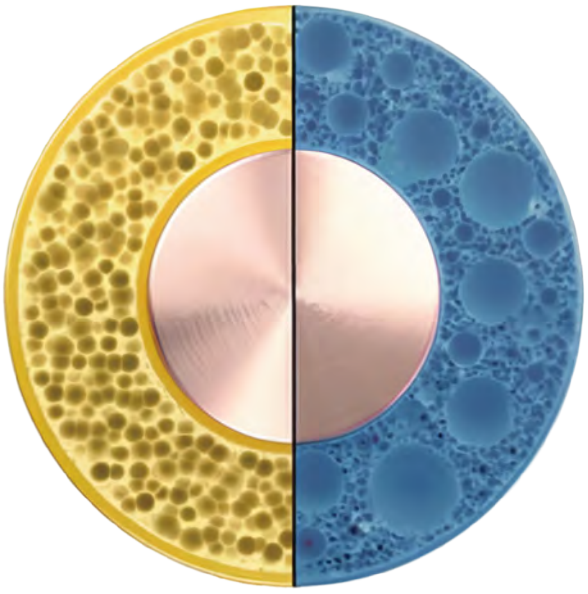
C&F Fluorochem

EVERFLON+

Foam Fluoropolymers



Introduction

Everflon+™ fluoropolymer foam resins have played an importantrole in the plenum cable market. The air content of the foam reduces the dielectric constant, loss factor (tangent),and permittivity of the electric insulation. Consequently,the signal speed and clarity improves at microwavefrequencies. These foams can be processed by a variety of techniques including molding methods, extrusion, and calendering. An attractive feature of Everflon+™ fluoropolymer foams is a reduction in the required weight of fluoropolymer per unit length of cable, thus reducing material cost.

Benefits of Everflon+™ Fluoroplastic Foams

The main driver for Everflon+™ fluoroplastic foams has been the insulation for data transmission cables. An example is coaxial cables that have relatively thick insulation. Its low dielectric constant and dissipation factor are desirable electrical properties. Air has the ideal dielectric constant (1.0). The ideal dissipation factor for data-cable insulation is zero.

Everflon™ Fluoropolymers have low dielectric constant and dissipation factor values . Everflon+™ fluoroplastic foams further reduces the dielectric constants toward 1.0 and moves the dissipation factors closer to zero because the resin is replaced with air-filled cells in the insulation. The decrease in the dielectric constant is proportional, for example, Everflon™ FEP insulation with 60% void content had a dielectric constant of 1.3. More uniform foam cell size and smaller cells yield foams with the best electrical properties.

The low dielectric constant and dissipation factor reduce signal loss and crosstalk. They also allow miniaturization of the circuitry because of the good insulation properties of fluoropolymers at very high voltages.These cables are suitable for transmission in microwave frequencies in excess of 10 GHz.

Everflon™ ETFE have somewhat higher dielectric constants and significantly larger dissipation factors than Everflon™ FEP and PFA. Everflon+™ Foamed ETFE have the advantage of stronger mechanical properties than perfluoroplastics, although their dielectric properties are inferior to those of FEP and PFA.

As wire and cable manufacturers compete to produce smaller cables while meeting modern electrical transmission requirements, the ability to reduce a materials dielectric provides flexibility in cable design. These demands, along with the need to produce better performing cables, require low dielectric materials that have reduced capacitance to enable higher transmission rates. Foaming insulation materials, i.e., perfluoropolymers and polyolefins, lowers the dielectric of the materials through introduction of air (dielectric of 1.0005) in the cells.

Decreasing the dielectric is directly proportional to the ratio between air (dielectric of 1.0005) and resin (PFA and FEP dielectric of 2.1). The linear decline in dielectric has a direct impact on capacitance. In order to realistically achieve 50% foam in Category cables, the insulation should be around 0.008" or greater. The results show a reduction in capacitance by 26% and 34% for 35% and 50% foam respectively.

The wall thicknesses can be applied to higher end lan cables, i.e., 6, 6A and 7 as well as specialty applications for aerospace, industrial and automotive. As the insulation thickness increases the weight savings per 1000' increases from 0.251 lb to 0.643 lb while capacitance drops from 51.48 pf/ft to 23.05 pf/ft. All of the calculations were completed with 24 AWG wire with a 0.0201" copper OD and a strand factor of 1.

Even with a 23% increase in wall thickness to accommodate for a 50% foam rate in the Category 6 cable, there is still 35% to 38% weighting savings with a 37% decrease in capacitance from 71.28 pf/ft to 44.82 pf/ft for Category 6 and 63.39 pf/ft to 49.76 pf/ft for Category 6A.

Weight Savings & Sustainability

Global trends are asking manufacturers to be conscious of material usage in current and future products. This trend is driven by an awareness to use resources more efficiently while maintaining and bettering performance. Everflon+™ foamed perfluoropolymers provide the unique ability to better the electrical and fire performance of the base resin, FEP or PFA, while increasing the longevity of the material in manufacturing and providing weight savings per 300M of cable produced. Regarding fire performance, Everflon+™ foaming perfluoropolymers reduces the combustible footprint of FEP and PFA when burned resulting in reduced flame spread and smoke generation.

In tradition lan cables when using high foam rates in the insulation and cross-webs. Due to the reduction in combustible footprint, it is also possible for cable designs to decrease the wall thickness of the jacket without sacrificing fire performance. While the weight per 300M of insulation decrease by 50%, the distance of production over a given quantity of material is increased by 50%. This is powerful in a market where procurement of materials is volatile and subject to a rapidly changing geo-political landscape.

Mechanical Performance & Retention

The mechanical performance of Everflon+™ foamed material is critical to its integrity in the wire and cable manufacturing process. Through small cell generation, it is possible to mitigate the steep mechanical decline.

Furthermore, short term oil and gas testing (UL44 and UL2556) have proven the self-skinning nature of the chemically foamable perfluoropolymer at 50% foam. This is critical from a process standpoint because a skinning extruder is not required for the manufacturing process to effectively achieve high foam rates in cross-webs and insulation.

At 50% foam there was 100% tensile retention of a monofilament. The skin on the foamed sample prevented any oil from penetrating the cell structure. Due to the self-skinning and cell size control of these high foam rate chemically foamable perfluoropolymers, they have the ability to meet 300 lb of crush as well as the flexibility test.

Chemical Foam Fluoroplastic

Traditionally, perfluoropolymers, i.e., Fluorinated Ethylene Propylene (FEP) and Perfluoroalkoxy (PFA), are foamed using nitrogen gas injected into the barrel of an extruder. The gas, coupled with the nucleating agent, produces a foam structure in the extrudate. The cell structure is generally between 0.002" and 0.005"3. To date, the so-called physical foaming, e.g., FEP has been the traditional method of foaming Fluoropolymers.

Everflon+™ CF series chemically foaming perfluoropolymers is unique in that it can be done on incumbent manufacturing equipment. Different from physical foaming, chemical foaming occurs when the foaming agent decomposes releasing gas into the resin system. At this point, the rheology of the melt is critical to control the formation of the cell structure because the viscous resistance of the fluid mitigates agglomeration of the dispersed gases. Through melt rheology control it ispossible to generate an average cell size of 0.0013".

Market Chance of Everflon+™ Fluoroplastic Foams

With control of cell structure during chemical foaming, it is possible to extrude perfluoropolymers as profiles, insulation and jackets at high foam rates with average cell size of 30um on incumbent manufacturing equipment providing reduction in dielectric constant for enhanced electrical performance.

Globally, 2.5 $x10^{18}$ bytes of data are generated every day. This is driven by the Internet of Things (IoT) and the exponential increase in connected devices. The wire and cable industry, the backbone of global IT networks, is tasked with developing higher frequency (x>500 Mhz) and lower latency (x<100 milli-seconds) data communications cables that will enable more data to be generated from more places at higher speeds.

These demands, coupled with the global trend to use resources more efficiently, have generated an innovative landscape that requires products to do more with less. Foaming polymers on existing manufacturing infrastructure provides the wire and cable industry with a unique set of capabilities to produce cables with better electrical properties while using less material.

Everflon+™ Foam Fluoroplastic in Wire & Cables

Everflon+™ FEP and PFA are excellent materials for wire and cable applications because they have innate fire retardancy, Limited Oxygen Index of 95% and electrical properties with a dielectric constant of 2.1. However, they are heavy compared to polyolefins, also electrically pure materials, with a specific gravity of 2.13 to 2.15 vs. 0.92 to 0.965. The ability to foam perfluoropolymers at 50% and greater decreases the specific gravity to 0.97 to 1.08, relatively close to polyolefins. The Plenum test, under UL 910, has shown lower flame propagation and decrease smoke generation from perfluoropolymers.

Everflon+™ foamed perfluoropolymers provide a unique confluence of material properties, i.e., electrical performance, fire retardancy and reduced weight that make them the ideal materials for highspeed low-latency data communications, especially for Plenum applications in the North American market.

Additionally, Everflon™ perfluoropolymers have excellent chemical resistivity, low coefficient of friction and high operating temperature (FEP = 200°C, PFA = 250°C) that are critical for aerospace, industrial and automotive applications. The ability to light-weight these cables, especially for aerospace and automotive applications, provides a competitive advantage to perfluoropolymers.

Lan Cable in Future

Over the past decade, higher frequency Category cables, Cat. 6 and Cat. 6A, have grown to 47% and 13.8% of the market, respectively, while lower frequency Category cables, Cat. 5e, have shrunk from 50% (2009) to 18.9% (2019) of the market.

While the market for Cat.6 and 6A cables is growing, the ability to increase transmission speeds (x >10 Gbps) and bandwidth (x>500 MHz) is difficult without sacrificing the effective distance of the cable, which is traditionally 100 m. Innovative materials with low dielectrics will be critical when designing higher frequency lower latency Category cables.

The ability to Everflon+™ chemically foam perfluoropolymers, i.e., FEP and PFA at high foam rates greater than 50% on existing manufacturing equipment enables manufacturers to build smaller, higher-frequency and lower-latency, copperbased communications cables through the reduction in dielectric constant. In addition, in a world driven by resource awareness, the ability to achieve better performance while increasing the longevity of material and reducing product weight offers a unique set of design characteristics not available to solid materials.

Foamed insulations, cross-webs and jackets for Cat6 and 6A lower the combustible footprint in buildings and are readily recyclable. As the future for high-speed data and power expands into autonomous vehicles, aircraft and space, the need for light-weighting without sacrificing electrical performance at higher operating temperatures will be paramount. The development of chemically foamable perfluoropolymers is an avenue to accomplish the aforementioned goal while promoting sustainability, recyclability and enhanced fire performance.

Power over Ethernet (PoE)

Other market factors such as fiber optics and Power over Ethernet (PoE) are shaping the data communications landscape of the future. Fiber optics have the ability to transmit high-speed data over a large bandwidth for long distances posing a threat to traditional Category markets.
However, with the development and roll out of PoE cables, copper-based data communications cables will be able to transmit up to 1 amp of current, generating a critical niche for Cat8.

PoE cables will provides power and communications to devices enabling the “Internet of Things” and a new generation of Enterprise technology. From smart lighting to Wireless Access Points (WAPs), PoE is changing the cabling infrastructure of the future by eliminating the need for two wires, one for power and then another for communications, to devices in homes, office buildings and someday autonomous vehicles. Therefore, the need for CMP rated Cat.6 and 6A cables using FEP, MFA and PFA insulation and cable components will remain a robust market.

Thinking for You

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