PTFE / ePTFE Components for Electronic Applications
Essential Use of PTFE in the Scope of the PFAS Regulation Proposal

PTFE is used in many applications as critical component. In the current proposal for future PFAS regulation, it is considered to be as potentially harmful as any other short chain or low molecular weight PFA substances. Therefore, a complete ban of PTFE on the European market, is called for.

Lenzing Plastics is in favor of a stringent PFAS restriction. However, PTFE as a polymer shall be excluded, generally, as being rated as Polymers of Low Concern (PLC)[1,2]. And especially applications, we are showing here, demonstrate that use of PTFE in the described ways and areas is both: very safe and very key.

1. PTFE Film for High Performance Cables: A Case Study

1.1. Introduction

This case study explores the utilization of PTFE film in high performance cables, focusing on its importance and benefits in producing high-frequency data and aircraft cables.

1.2. The Benefits of PTFE in Cables[3,4]

The demand for high-frequency data and aircraft cables with enhanced performance and reliability has led cable manufacturers to seek advanced materials. PTFE, a fluoropolymer with unique characteristics, has gained prominence in cable design, ensuring efficient signal transmission and durability. PTFE has become a preferred material due to its exceptional properties:

- Electrical Performance
  PTFE is an excellent dielectric material with a very low dielectric constant and very low dissipation factor. It ensures minimal signal loss and reflection, making it an ideal choice for high-frequency applications, where signal integrity is critical.
- High Temperature Resistance
  PTFE exhibits remarkable thermal stability, retaining its electrical properties over a wide temperature range. This characteristic is vital in aircraft cables that are subject to varying environmental conditions, ensuring consistent performance under extreme temperatures.
- Chemical and Moisture Resistance
  Cables, exposed to harsh environments, may encounter moisture or chemical contaminants. PTFE's chemical inertness and moisture resistance prevent degradation and maintain cable integrity, thus, performance, over an extended period.
- Mechanical Strength and Flexibility
  PTFE films and tapes exhibit high mechanical strength and flexibility, enhancing the cable's resistance to physical stress, abrasion and bending. This feature is particularly

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[1] B. Ameduri, H. Hori, *Chem. Soc. Rev.,* **2023***, 52,* 4208
[2] B.J. Henry, J.P. Carlin, J.A. Hammerschmidt, R.C. Buck, L.W. Buxton, H. Fiedler, J. Seed, O. Hernandez, *Integr. Environ. Assess. Manag.,* **2018***, 14,* 316
[3] J.G. Drobny, *Technology of Fluoropolymers*, **2009**, *3*
[4] B. Ameduri, *J. Chem. Eur.,* **2018***, 24,* 18830

advantageous in aircraft cables that need to withstand challenging installation conditions.[5]

- Non-Flammability[6]
  PTFE shows an LOI (limiting oxygen index) of >95% (it would need an environment with more than 95 Vol% oxygen for burning) and a lack of sustained combustion once the ignition source is removed. This is absolutely crucial in aerospace applications, where failure can have catastrophic consequences.

1.3. Case Study: PTFE Film Application in Low Loss and High-Frequency Cables

1.3.1. Scenario

A telecommunications company aimed to upgrade its network infrastructure by introducing high-frequency cables to improve data transmission speed and reduce signal loss.

1.3.2. Challenge

The company needed a cable with low signal attenuation and high electrical performance to meet the demands of their advanced network.

1.3.3. Solution

The cable manufacturer opted for PTFE film as the dielectric material. By using PTFE, the cable's signal integrity was preserved, leading to increased data transfer rates and a substantial reduction in signal loss. PTFE's high temperature resistance ensured consistent performance even in challenging outdoor installations.

1.3.4. Results

The adoption of PTFE in high-frequency cables resulted in improved network performance, reduced latency, and enhanced reliability, meeting the growing needs of the telecommunications company and its customers.

1.3.5. Alternatives to PTFE in High-Frequency and Aircraft Cables

While PTFE offers exceptional properties, some specific applications may require alternatives due to cost constraints.
Low-cost alternatives that are used, whenever technically possible, include:
Polyethylene (PE): PE is widely used as a low-cost alternative to PTFE in certain high-frequency cable applications. It offers good electrical performance and is suitable for less demanding environments.
Polypropylene (PP): PP is another cost-effective alternative to PTFE in cable insulation. It provides reasonable electrical properties and is often used in applications where extreme temperature resistance is not required.

As mentioned, those alternatives only work for less demanding environments, but e.g. not for critical components in the aviation industry, satellites, marine systems, etc.

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[6] D.W. Smith Jr., S.T. Iacono, S.S. Iyer (Eds.), *Handbook of Fluoropolymer Science and Technology,* **2014,** *Chapter 25*

1.3.6. Conclusion

PTFE film has proven to be an essential material in cable manufacturing, especially for high-frequency and aircraft cables, due to its exceptional electrical properties, high temperature resistance, chemical inertness and the fact that it cannot burn (LOI 95). The case study showcased how PTFE film significantly improved the performance of high-frequency cables, meeting the demands of modern telecommunications networks. Although alternatives exist, PTFE remains the preferred choice in applications where top-notch electrical performance and reliability are paramount. Selecting the most suitable material depends on specific cable requirements, budget considerations, and environmental conditions.

2. Manufacturing

2.1. PTFE processing

At Lenzing Plastics, we source PTFE polymer as resin from leading suppliers, globally. For many years already, free from PFOA and PFOS. Due to the PFAS campaign, 3M as one of the last remaining PTFE producing companies announced to stop PTFE polymer production in Europe and shut down the plant, completely. Consequently, in the future, import from other parts of the world will be required. We blend the resin with lubricant (low boiling *iso*-alkanes) and extrude it into a rod which is, then, calendared into a film. The lubricant is fully evaporated during the process, during heating up and drying the film. The exhaust air is treated thermally to destroy all potentially harmful substances or particulates. No generation of short-chain PFAS could be detected in the course of the process, so far. Next step is stretching of the film/tape, for orienting the polymer chains, thus, applying strength to the tape. And finally, it is slit and collected on spools. In summary, at Lenzing Plastics, PTFE is only converted physically from a resin into a film and tape, subsequently. No other PFAS substances are added/generated during the process.

2.2. Raw material manufacturing

Our suppliers did phase out of usage of PFOS and later PFOA already. Long before the radical restrictions legally got enforced. For selected PTFE resins (Suspension PTFE), PFAS polymerization aids are not necessary, thus not used. For fine powder resins (Emulsion PTFE) there is still no viable alternative existing[7,8]. However, R&D is in progress to work on it[9]. Introduction of a strict regulation for raw material manufacturing practice in this regard would be highly appreciated by Lenzing Plastics.

3. End of product lifecycle

PTFE is a very stable and long-lasting product[10]. In most of the applications, including electronics, it is among other reasons used, because of its longevity and durability. Therefore, products made of PTFE are less often exchanged, replaced and disposed than alternative materials. But at one point of time also the PTFE components are disposed. If incinerated in state-of-the-art facilities,

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[7] B. Ameduri, J. Sales, M. Schlipf, *ICRL,* **2023***, 1,* 18

[8] B. Ameduri, *J. Fluorine Chem.,* **2023***, 267,* 110117

[9] R. Chauhan, G. Kumar, P.s. Rao, N. Soni, B.s. Bhattacharya, A. Dutta, A. Shukla, A.M. Patel, *PCT Application,* **2020***,* WO 2021/070159 A1

[10] B. Ameduri, H. Hori, *Chem. Soc. Rev.,* **2023***, 52,* 4208

no PFAS are emitted into the air[11,12]. Due to the strong carbon fluorine bond (the strongest that carbon could have to any other atom), there will be no negative impact on the environment, if placed on landfill: PTFE will not be dissolved through water, as it is not soluble therein and will not degrade to smaller particles[2]. Thermal degradation will only happen at drastically elevated temperatures (higher than 350°C) and long exposure at the same time.
From technical viewpoint, also recycling is feasible. However, due to the very low amounts of PTFE material, in general, it is economically challenging to organize collection of material for recycling.

4. Summary

The described PTFE tape for cable manufacturing is only one use-case in the field of electronics[13]. Fluoroplastics fill critical needs for insulation in terrestrial, aviation, and space applications[6]. PTFE membranes for fuel cells, films in Zinc-Air batteries for hearing aids, or PTFE fabrics in electrolysis are other examples, where the outstanding dielectric performance of PTFE is key. And beyond the capabilities of Lenzing Plastics, there are many more usages of fluoropolymers in electronics (e.g. semiconductor industry), essential for a modern world of high frequency data transmission.

Therefore, we call for a general exemption (not only extended derogation time) for the use of PTFE in all electronic applications in a future PFAS regulation proposal.

In case of any questions, we are available to provide further details.

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[11] K. Aleksandrov, H.J. Gehrmann, M. Hauser, H. Mätzing, D. Pigeon, D. Stapf, M. Wexler, *Chemosphere,* **2019**, *226,* 898
[12] W. Tsang, D.R. Burgess Jr., V. Babushok, Combustion Sc. and Technol., 1998,139, 1
[13] B. Ameduri, *Macromol. Chem. Phys.,* **2020**, *221,* 1900573