SHPP's Inputs to the Public Consultation Comments to Annex XV PFAS Restriction Proposal

Question number 6: Missing uses: PTFE Used as an Anti-Drip Additive in Flame Retardant Polycarbonate Resins and Blends for Photovoltaic Devices

Executive Summary

SABIC's Specialties business (SHPP) produces a range of highly differentiated products, including high-performance thermoplastics, compounds, and additives that meet complex thermal, mechanical, optical, and electrical property requirements.

Flame retardant polycarbonate (FR PC) resins and blends with Polytetrafluoroethylene (PTFE) anti-drip additives play a safety-critical role while providing functionality in photovoltaic applications such as connectors, junction boxes, and inverters. These FR PC resins and blends used in such applications are inherently tough materials in harsh environments and provide device integrity, especially during cold temperature impact events and maintenance activities, so the device continues to function, and does not produce an electrical hazard (short circuit, shock hazard) or a fire hazard. Because these plastics are inherent insulators, they also provide a needed significant reduction in electrical shock resistance when used in these high-voltage applications. By increasing ignition resistance, the PTFE used in FR PC resins and blends helps prevent injuries and property damage by lowering the probability of a fire event. If a flame event does occur, they help prevent the loss of life and property by reducing the risk of a small fire growing out of control.

All the safety and functionality advantages must be maintained over time in the outdoor environment. This environment requires UV and water/moisture resistance, and property retention over a wide range of temperatures, including resistance to cold temperature impact and maintaining ductility. The specific devices where these FR PC resins and blends with PTFE anti-drip additives are used (for example, connectors, inverters, and junction boxes) all see high voltages. A failure of any one of these devices at least would compromise the PV system functionality but could also lead to immediate fire hazards and immediate or hidden shock hazards to anyone interacting with the system – maintenance, repair, adjacent activities, etc.

Emissions of PTFE during the use phase of final products are negligible because PTFE is bound within the PC resins and blends. The emissions in the waste stage depend on the pre-treatment method. A recent review published by the Society of Environmental Toxicology and Chemistry (SETAC) in 2023 shows that PTFE does not release substances of toxicological or environmental concern, and fluoropolymers are stable and not expected to transform to dispersive nonpolymeric PFAS.

SHPP's extensive research has not found any alternatives that provide adequate flammability performance for FR PC resins and blends while also maintaining adequate impact resistance and ductility, cold temperature impact retention, weatherability, and electrical tracking resistance. If an alternative is found, material qualification testing will be needed, companies may need to make changes to their manufacturing equipment and processes to use the new material, and part qualification testing would be needed. Given the absence of alternatives, SHPP feels it would be appropriate to allow for a 12-year derogation to have sufficient time to invent new materials or develop viable alternatives for PTFE used as an anti-drip additive in flame retardant polycarbonate resins and blends, and to have sufficient time for the steps needed to make and qualify final parts.

Substance Information

Substance Name: Poly(1,1,2,2-tetrafluoroethylene)
Synonyms/Abbreviations: PTFE
Molecular formula: $(C_2F_4)_n$
EC/List no.: 618-337-2
CAS number: 9002-84-0
Type: Solid
Application: PTFE used as an anti-drip additive in flame retardant polycarbonate (FR PC) resins and blends for photovoltaic applications

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1. Technical description

1.1 Application description

SABIC's Specialties business, SHPP B.V. (hereafter "SHPP"), produces a range of highly differentiated products, including high-performance thermoplastics, compounds, and additives that meet complex thermal, mechanical, optical, and electrical property requirements.

Mouldable PTFE-containing flame-retardant polycarbonate (FR PC) resin and blends are commonly used in photovoltaic applications such as connectors, junction boxes, inverters, etc. These compounds typically comprise a neat base polycarbonate resin or blend, a flame retardant, and a PTFE polymer, which serves the purpose of an anti-drip additive during a potential fire event. Additionally, these FR PC formulations may include other additives and pigments.

FR PC resins and blends containing PTFE are a semi-finished product in the form of plastic pellets that are subsequently injection moulded or extruded into shapes and final parts. The primary purpose of these compounds is to provide flame-, electrical-, and impact-resistance to outdoor photovoltaic (PV) application enclosures, and to help ensure the safe, reliable functioning of the applications over the lifetime of the device.

These compounds are in many cases optimized for the specific requirements of the final applications. Some examples include:

- Excellent flame resistance
- High-voltage electrical properties – including electrical tracking resistance
- Cold temperature impact and ductility/flexibility
- Overall mechanical / impact strength
- Temperature resistance / long-term thermal aging
- Weather resistance (retention of properties) – UV and water exposure
- High continuous use temperatures
- Corrosion resistance
- Intricate moulded-in functionality (e.g., interlocking PV connector pieces)

Over the past 20+ years, FR PC resins and blends using PTFE as an anti-drip additive have been utilized in PV applications due to their differentiated properties. Typically, these applications must undergo complex and extended-life testing and meet demanding regulatory and industry prevailing standards requirements to ensure their safety and functionality throughout their expected or mandated lifespan.

The moulds used to fabricate the PV components using the PTFE FR PC resins and blends are often complex and designed to fabricate parts to very tight tolerances and to fulfil the applications' technical and regulatory requirements. Any significant change in composition/formulation of the compound, such as eliminating the PTFE and/or replacing it with a possible alternative, could result in needing to modify or replace the moulds to produce parts with the same final design and geometry. Furthermore, the final assembly would often need to be completely re-tested and respecified to ensure proper functioning over its lifetime. Since photovoltaic devices are regulated, safety critical, and expected to last 20 years or more, new materials often require extensive and severe long-term testing, which can take several years of testing and validation to complete a substitution. For instance, a common long-term heat aging test, called the Relative Thermal Index, routinely takes about a year to complete, but could take up to 2 years in case no direct comparison material is available. Then customer-specific testing would be needed to qualify a new material in each separate application. Given the re-testing and re-specifying, coupled with changes in design and production, part substitution can easily take several years to complete, and the more complex devices could extend the timeline further.

Some examples of current commercial applications of FR PC resins and blends with PTFE anti-drip additives are described below.

Inverter (Grey Box, Foreground) Behind PV Panels, with Junction Box, Connectors and Wiring

Connectors

Connectors are very critical parts of any PV system. Typically, solar panels come with wires connected on one end to the junction box and on the other end to a solar panel connector. The PV connector is used to interconnect solar panels in PV installations. The main functions of the device are ensuring power continuity and electricity flow throughout the whole solar array.

Junction boxes

Solar junction boxes are protective enclosures that house electrical components for combination, connection, and termination for PV systems. The boxes protect the electrical connections, vital to the operation of the solar panels, from environmental conditions. Wire leads connecting the solar panel to the string (a series-connected group of solar panels) and bypass diodes, which help to optimize system performance, are located inside the junction box.

(Micro) Inverters

A solar inverter or PV inverter is a type of power inverter that converts the variable direct current (DC) output of a PV solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. Inverters are critical balance-of-system (BOS) components in a PV system, allowing the use of ordinary AC-powered equipment. Solar power inverters have special functions adapted for use with PV arrays, including maximum power point tracking, which optimizes system performance, and anti-islanding protection, which is a safety-critical feature to keep the PV system synchronized with the electrical grid.

1.2 Function of material/article and PFAS content

For PV devices, the PTFE anti-drip FR PC resins and blends provide a combination of flammability performance with minimal flame retardants to preserve electrical properties, cold temperature impact resistance and other mechanical properties, heat resistance and more. These properties facilitate maintenance-free, reliable, and proper functioning of safety-critical components in PV applications over a long lifetime that can be up to 20 years or more.

In general, flame retardant additives are only added for flame performance and could lessen other properties such as impact, ductility, and outdoor weather performance. The PTFE preserves those other properties necessary for PV devices. PTFE as an anti-drip agent is typically used in the range of 0.1-0.5% by weight.

Due to the high voltages and currents involved, PV systems have a risk of fire and a risk of electrical shock. PV safety standards use material fire resistance and electrical insulation requirements as two critical safety elements to help mitigate these risks. For fire resistance, there are several common industry test standards that require materials to resist ignition, burning, and dripping flaming particles. One common standard is "*UL 94, the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*"[1] that is now harmonized with IEC 60707, 60695-11-10 and 60695-11-20, and ISO 9772 and 9773. The PV device standards tend to use the more stringent, better performing flame classifications of either V-0 or 5VA/B for materials that are used as enclosures, structural parts and electrical insulators. These ratings require that samples do not drip flaming particles during the tests.

[1] https://www.shopulstandards.com/ProductDetail.aspx?productId=UL94_6_S_20130328

Since thermoplastics are designed to be shaped/flowed by heat, direct flame application can lead to melting and dripping before or during ignition. Any flaming melting/dripping has the chance of spreading flame beyond the initial event and is almost always more pronounced in thinner rather than thicker gauges of thermoplastics, all else being equal. Based on Table 2 (section 4.1), PTFE is the only viable additive that can inhibit dripping and retain all the other properties necessary for PV applications.

1.3 PFAS properties required in material/article

The PFAS used in these types of formulations is a fully fluorinated polymer - Polytetrafluoroethylene (PTFE). The types of PTFE used as an anti-drip/enhanced structural integrity additive for thermoplastic compounds help the overall FR additive package by providing the following key product attributes:

- Increased resistance to ignition
- Reduced rate of flame spread once a fire has started

FR formulation strategies for thermoplastics typically are combinations of multiple additives. These generally fall into two classes that typically work synergistically: flame suppressants and anti-drip additives. PTFE additives provide a unique, critical role as structural integrity/anti-drip agents, which allow for minimal FR additives. During melt processing where high mechanical shear exists, PTFE compounds that are designed to be anti-drip additives do not melt but undergo a physical form change from being semi-spherical particles to highly elongated fibrils in this high temperature, high shear environment. These very high aspect ratio fibrils form an entangled network inside the polymer matrix. During a flame event, this network does not burn/ignite but helps promote char formation and provides much higher melt strength to the plastic part, significantly improving resistance to deformation and/or loss of structural integrity as the polymer matrix burns (e.g., no flaming drips and enhanced resistance to further heat release from the flame initiation point).

A non-exhaustive list of other properties that make a PTFE anti-drip additives in FR PC resins and blends differentiated materials in PV applications are:

- high melting point
- high resistance to thermal degradation
- very high resistance to chemicals
- very low surface energy
- electrically non-conductive
- inert reactivity due to perfluorinated structure and high molecular weight.

As an anti-drip additive in FR PC resins and blends, PTFE is generally used in loadings of 0.1-0.5 wt% of the bulk compounded product. Since the density of a perfluorinated polymer is higher than that of the base resin, the volume fraction of PTFE is lower than the weight percentage cited.

One key electrical property requirement of PV connectors and junction boxes is the Comparative Tracking Index (CTI) Test (versions of this test are IEC-60112[2] and ASTM D3638[3]). This test measures the resistance of a material to form a conductive, carbonized track on its surface that could lead to a short circuit, a fire, and/or an otherwise neutral part being energized (risk of electrical shock). To minimize the amount of material and to design smaller, more efficient parts, the best CTI rating is usually requested by PV system OEMs, meaning a CTI voltage of $\geq$ 600V, also called a CTI Performance Level Category (PLC) of 0 according to the UL746A[4] standard.

Since almost all PV systems are installed outdoors, long-term weatherability and temperature resistance are properties critical to both performance and safety. Standards such as UL 746B[5] and 746C[6] use long-term aging tests (UV, water exposure, and temperature) to help ensure that properties such as flame and electrical resistance, and mechanical strength are retained for safe operation. Specifically, an outdoor rating of f1 comes from UL746C, and Relative Thermal Index Testing (RTI) comes from UL 746B. A relatively simple RTI test takes 8-10 months (up to 2 years if more complicated), while f1 testing takes about 3 months. Assuming there is laboratory availability, additional time is needed for sample preparation and logistics, which can add another 3 months to the process. PTFE as an anti-drip additive is exceptional in that it is highly resistant to thermal and UV degradation, does not migrate out of the FR PC resins and blends when exposed to water, and does not significantly change other properties while improving flame performance.

2. End-of-Life

Emissions during the use phase of final articles are negligible, because PTFE is bound within the polymer. However, it is understood that anti-drip PTFE in products will eventually enter the waste stage with levels in the polymer matrix at 0.1-0.5% by weight.

In the waste phase some emissions could occur, - the amount of which depends on the waste (pre-) treatment method, e.g., recycling/re-use, landfilling and incineration. Thorough incineration will decompose PTFE and prevent other PFAS from forming. When recycling/re-use and landfilling are chosen, PTFE remains a fluoropolymer that is not water soluble or mobile and therefore, does not present the specific hazards and risks of non-polymeric PFAS.

There is considerable data demonstrating that PTFE do not release substances of toxicological or environmental concerns[7].

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[2] https://webstore.iec.ch/publication/32739
[3] https://www.astm.org/d3638-21e01.html
[4] https://www.shopulstandards.com/ProductDetail.aspx?productId=UL746A_6_S_20120906
[5] https://www.shopulstandards.com/ProductDetail.aspx?productId=UL746B_5_S_20180815
[6] https://www.shopulstandards.com/ProductDetail.aspx?productId=UL746C_7_S_20180205
[7] Korzeniowski, S.H., Buck, R.C., Newkold, R.M., kassmi, A.E., Laganis, E., Matsuoka, Y., Dinelli, B., Beauchet, S., Adamsky, F., Weilandt, K., Soni, V.K., Kapoor, D., Gunasekar, P., Malvasi, M., Brinati, G. and Musio, S. (2023), A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers. Integr Environ Assess Manag, 19: 326-354. https://doi.org/10.1002/ieam.4646

2.1 Concerning Exposure to the Environment

A recent review published by the Society of Environmental Toxicology and Chemistry (SETAC) in 2023 states that emissions of PTFE during the use phase of final products are negligible because PTFE is bound within the polymer. The emissions in the waste stage depend on the pre-treatment method. PTFE does not release substances of toxicological or environmental concern, and fluoropolymers are stable and not expected to transform to dispersive nonpolymeric PFAS.

When the articles containing PTFE anti-drip additives reach their end-of-life, various waste (pre-) treatment methods are commonly practiced by the industry, e.g., recycling/re-use, landfilling and incineration. Thorough incineration will decompose PTFE without formation of non-polymeric PFAS. When recycling/reuse and landfilling are chosen, polymeric PTFE remains as a fluoropolymer that is not water soluble or mobile and therefore, does not present the specific risks nor hazards as those of non-polymeric PFAS. There is considerable data demonstrating that PTFE do not release substances of toxicological or environmental concerns[7].

In contrast to non-polymeric PFAS, PTFE being a polymeric material is chemically, thermally, and biologically stable and therefore is not expected to transform to dispersive nonpolymeric PFAS when disposed of in landfill. A recent study presented results from OECD guideline biodegradation studies demonstrating that PTFE is stable under environmentally relevant conditions. Furthermore, fluoropolymers that meet the criteria to be considered Polymer of Low Concern (PLC), have negligible leachables, unreacted monomers, and oligomers most likely destroyed in fluoropolymer use processing and would therefore not be expected to significantly contribute to landfill leachate.

Available data reveal that fluoropolymers are mineralized (i.e., all C–F bonds broken, hydrofluoric acid generated, and scrubbed to calcium fluoride) under commercial Waste-to-Energy (WtE) incineration operating conditions. In recent pilot scale studies representative of full-scale WtE facilities, the most common form of end-of-life destruction conducted on PTFE found that combustion converted the fluorine into controllable hydrogen fluoride gas and that, of the 31 PFAS studied, no fluorine-containing products of incomplete combustion were produced above background levels. Further, a recent study investigating the presence of PFAS in waste incinerator flue gas stated: "based on a literature review, RIVM (the Dutch National Institute for Public Health and the Environment) expects that most of the PFASs will largely degrade during the incineration process and then be removed when the flue gases are cleaned. The remaining PFASs are expected to be removed during the recovery of the carbon dioxide". The RIVM report[8] affirmed that PTFE is the most stable fluorine-containing polymer. The RIVM report concluded that complete thermal decomposition of PTFE is achieved at a temperature of approximately 800 °C.

[8] Bakker, J., Bokkers, B., & Broekman, M. (2021). Per- and polyfluorinated substances in waste incinerator flue gases (RIVM Report 2021-0143). https://www.rivm.nl/bibliotheek/rapporten/2021-0143.pdf

3. Availability of substitutes

3.1 Alternative applications

There are no known alternatives to PTFE used as an anti-drip agent in FR PC resins and blends for photovoltaic applications that result in the same flammability, electrical, impact, weathering, and other properties and application performance. Alternative formulations/compositions would require potentially long-term re-testing of the material, and part re-design and re-qualification.

Any alternative solution must first be technically feasible and meet regulatory requirements. It is then likely that in most cases the parts made from the alternative solution will either have a shorter lifetime/more waste (because of failures related to impact/ductility) or will be unable to meet other application requirements such as CTI ratings $\geq$ 600V. In-service failures of parts also carry the risk of fire and electrical shock events.

3.2 Alternative substances

PV device manufacturers must constantly balance meeting both safety standards and real-world performance requirements. While there are many thermoplastics available that can meet some of the requirements for PV devices, as listed in the Table 1 below, none of them have the balanced properties necessary to meet all the requirements for a given PV device. In addition to flame resistance and a CTI value of $\geq$ 600V, two key physical properties a material must have for these types of applications is cold temperature impact resistance and ductility/flexibility. Impact resistance is the material's inherent resistance to permanent deformation or breaking caused by a force acting upon it (e.g., a collision with another object, a drop, etc.). Ductility/flexibility is a material's inherent ability to bend without breaking. An example of an application requiring these properties is a PV connector, and an example of a suitable material is an FR polycarbonate resin or blend with PTFE as an anti-drip additive. These small, self-locking devices must be able to be de-coupled and re-coupled for maintenance. They rely upon polycarbonate's inherent toughness in cold temperatures to ensure the devices do not break and rely on PTFE as an anti-drip additive to meet safety requirements. The PTFE is able to survive any environment in which the polycarbonate can be used.

There are several ways to determine a material's impact resistance and ductility. Two common methods are Notched Izod Impact (NII) and Tensile Elongation (TE). These techniques measure the amount of energy that a material can absorb during impact or the amount of elongation (as a percentage of the initial gauge length) that a material will deform before breaking. These tests are performed in controlled laboratory settings, following standardized test methods such as ASTM D256[9]/ ISO 180[10] for NII and ASTM D639[11]/ISO 527[12] for TE. The higher the values in these tests, the tougher the material is and the more resistant it is to cracking or breaking. Polycarbonate and its blends are used so prevalently in the photovoltaic industry because of the unique balance

[9] Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics (astm.org)
[10] ISO 180:2019 - Plastics — Determination of Izod impact strength
[11] Standard Test Method for Tensile Properties of Plastics (astm.org)
[12] ISO 527-1:2019 - Plastics — Determination of tensile properties — Part 1: General principles

of flame resistance and toughness they can provide. Table 1 shows a broad range of unfilled materials' flame resistance, as measured by their UL94 V0 and 5V-B ratings, along with their surface tracking resistance, weatherability, cold temperature impact retention and inherent toughness compared to an FR polycarbonate blend with PTFE as an anti-drip agent reference. Impact and ductility data is shown as a percentage decrease in Notched Izod Impact and Tensile Elongation.

Property Comparison							
	Property	Flame Resistance	Impact/Crack Resistance	Ductility	Impact/Crack Resistance	Weatherability	Surface Tracking
		Passes UL94 V-0 @ 1.2 mm / 5V-A/B @ 2.5 mm	Notched Izod Impact, % of Reference	Elongation @Break, % of Reference	Cold Temperature Impact Retention	f1 (per UL) Property Retention	CTI ≥ 600 V
Material (non-reinforced)	New Polycarbonate Blend w/ PTFE Anti-Drip	☑	100% (Ref)	100% (Ref)	☑	☑	☑
	PPE/PS	☑	12% (88% decrease)	14% (86% decrease)	☒	☑	☑
	Polyetherimide	☑	4% (96% decrease)	55% (45% decrease)	☑	Limited grades available	☒
	PPSU	☑	83% (17% decrease)	55% (45% decrease)	☑	☒	☒
	PEEK	☑	11% (89% decrease)	46% (54% decrease)	☑	☒	☒
	Polypropylene Copolymer FR, Talc Filled	☑	13% (87% decrease)	12% (88% decrease)	☒	☒	☑
	Polyamide FR, Glass Fiber Filled	☑	11% (89% decrease)	2% (98% decrease)	☒	☒	☒

Table 1. Property comparisons of existing materials

As can be seen in Table 1, several materials can achieve the necessary flame resistance. However, none of these materials have a comparable toughness to the FR PC blend with a PTFE anti-drip additive. The significantly lower ductility and toughness makes most of these materials unsuitable for use in applications that require inherent resistance to cracking and breaking, which are ubiquitous requirements in the design and manufacturing of PV devices.

Also, most of the alternative materials cannot achieve the necessary mix of other properties, such as CTI ≥ 600V, cold temperature impact retention, and outdoor weatherability.

4. Development of possible substitutes

4.1 Actions taken to develop alternative applications or alternative substances

Owing to its unique physical property profile leading to exceptional performance as an anti-drip additive (e.g., high heat resistance, excellent compatibility across a broad range of materials, chemically inert, fibrillation/deformation under shear, inherent resistance to ignition, efficacy at very low loadings), there are no known direct replacements for PTFE as an anti-drip agent in FR PC resins and blends for photovoltaic applications.

FR PC resins and blends are often desired for their cold temperature impact strength. For these PC resins and blends, there are several strategies that can be employed to increase resistance to dripping by increasing melt strength or the stiffness of the material with either viscosity enhancers or mechanical fillers. For example, melt strength improving, compatible polymers that can increase the zero-shear viscosity of the system (e.g., highly branched PC) can be used to boost the melt strength. Because this approach significantly increases the viscosity of the system, it does improve the system's resistance to deformation as the temperature increases. Similarly, glass fiber or other inorganic fillers (e.g., clay, talc, carbon fiber) can be added to increase the stiffness or modulus of the material. Table 2 shows the flame resistance, CTI performance and the inherent toughness of formulations using these strategies as compared to a PTFE anti-drip additive.

Property Comparison in PC

PTFE Replacement

Property	Flame Resistance	Surface Tracking	Impact/Crack Resistance	Ductility
	Passes UL94 V-0 @ 1.2 mm / 5V-B @ 2.5 mm	CTI ≥ 600 V	Notched Izod Impact, % of Reference	Elongation @Break, % of Reference
PTFE	☑	Does not lessen CTI performance	100% (Ref)	100% (Ref)
Branched/High Viscosity Resin	☒	Irrelevant due to not meeting flame requirements	14% (86% decrease)	44% (56% decrease)
Mineral (Glass, Talc, Clay)	☒	☒	16% (84% decrease)	6% (94% decrease)
Carbon Fiber	☑	☒	10% (90% decrease)	1% (99% decrease)

Table 2. Comparison of the flame resistance, CTI performance, and ductility/toughness of various classes of PTFE anti-drip replacement options compared to a polycarbonate blend reference sample with a PTFE anti-drip additive.

As can be seen by the property comparisons, these approaches have a significant effect on the impact resistance and ductility of the materials. Unlike PTFE, these additives must be used at relatively high loadings (10–50 times or more than PTFE loadings) to have a significant effect on anti-drip properties. These high loadings of fillers cause a dramatic decrease in the ductility and impact resistance of the material, and some deteriorate the CTI performance. This significant trade-off in properties makes them unsuitable for use in applications that require inherent resistance to cracking and breaking, and excellent CTI performance, which are prevalent requirements in the design and manufacturing of PV devices.

4.2 Stages and timeframes needed to establish possible substitutes

There are no alternatives to PTFE available today for use as anti-drip agents in FR polycarbonate resins and blends that result in the same extraordinary properties and application performance for photovoltaic applications. A wide range of potential alternatives have already been tested and have been found to fail to provide the necessary properties. A new round of extensive, fundamental laboratory research will be needed to attempt to identify a completely new material, unknown today, that may potentially be developed into an alternative to PTFE. SHPP expects it may take up to 8 years to carry out this basic research.

If a new alternative material is identified it would take several more years to test, qualify, certify, and start manufacturing parts from this replacement material. Companies may need to make changes to their manufacturing equipment and processes to use the new material in their moulding lines. These changes to manufacturing equipment and processes may be significant and require extensive time and capital investment.

Product requalification is a very time-consuming exercise that will require extensive resources over many years. The completion of this task will require sufficient test house capacity and transition time to requalify all existing flame retardant polycarbonate resin and blend parts in products that are used in Europe for photovoltaic safety and performance. For a company with a wide range of existing product designs, SHPP estimates it could take up to 5 years to carry out the necessary manufacturing equipment changes and product re-qualifications.

5. Request for derogation for use of PTFE as an Anti-Drip Additive in Flame Retardant Polycarbonate (FR PC) Resins and Blends for Photovoltaic Devices

Given the two derogation choices, SHPP respectfully requests a 12-year derogation. Since there are no PTFE alternatives available that can provide the same performance functions and the same/better safety benefits, at least a 12-year derogation is absolutely needed. The material industry will need to develop a better solution (or equivalent) if possible, and all the moulders and OEMs from the photovoltaic industry who use this type of material will need to re-design and re-test their parts, devices, and systems.

Since the proposed derogation is only for PTFE, one additional point of reference is the UK's recently published PFAS regulation proposal. They limited their proposed restriction to certain and specific PFAS substances and did not apply the restrictions to an entire class of fluorine substances. Of particular note, they are excluding fluoroplastics and fluoroelastomers (such as PTFE, PVDF, etc.), which they consider as low hazard groups, from their proposed regulation. Presumably, this is because fluoropolymers (such as PTFE) are not water soluble, are not mobile, and do not present the same level of environmental hazards as low-molecular-weight non-polymeric PFAS. SHPP believes this also provides a basis for a total exemption of PTFE from the potential REACH restrictions if one is to be considered.