Comments for Annex XV restriction report on Per- and polyfluoroalkyl substances (PFAS)

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FUJIFILM Corporation

**Introduction**

First of all, we would like to express our gratitude to ECHA for their long-standing efforts and cutting-edge activities to protect human health and the environment. We operate around the world and are firmly committed to protecting people's health and the environment, and complying with chemical regulations in many countries and regions.

FUJIFILM Corporation has carefully considered the PFAS restriction proposal of Annex XV report and would like to share information particularly on PFAS and its coating technology in displays.

## 1. Summary

Due to their usefulness, PFAS are widely used in materials for displays, including consumer displays such as TV and computer monitors, tablets, mobility displays (such as car monitors), and industrial equipment monitors, including medical usage. These displays are imported into the EU containing PFAS. Therefore, if the PFAS restriction is implemented, the display industry will be greatly affected.

On the other hand, in displays, only a small amount of PFAS is contained, and the risk of exposure is low. We are currently considering switching to PFAS substitutes at the expense of development costs, but the switching is extremely difficult and take a long time.

In the case of PFHxA regulation, fluorinated compounds with short perfluoro chains could be considered for substitutes. However, if the entire PFAS is regulated this time, it will be necessary to explore new non-fluorinated alternative materials with the same performance as PFAS. This is considered extremely difficult to explore.

In addition to confirming the necessary quality and mass production applicability at the material manufacturer, it takes a long time to evaluate and adopt customers in the long supply chain, and it is necessary to consider the point that long-term supply is required in repair parts.

For these reasons, we request a 12-year transition period (13.5 years from the date of entry into force) in the field of displays. We also strongly request the construction of a new system that allows for additional extensions of the transition period after the transition period expires. We would like to ask ECHA to consider a new opinion submission system or process that will allow the transition period to be extended in accordance with the RoHS exemption.

**In this comment, we are requesting the following specific exemptions for application.**
**As exemptions, Paragraphs 1 and 2 shall not apply to the followings:**

a. **For displays used in electrical, electronic equipment, and mobility; until 13.5 years after EiF (entry into force).**
b. **For functional coatings used in electrical, electronic equipment, and mobility; until 13.5 years after EiF (entry into force).**

We request the creation of a new system that allows for additional extensions of the transition period after the transition period expires. We would like to ask the authorities to consider a new submission system and process that will allow the transition period to be extended in accordance with the RoHS exemption.

## 2. Preface

FUJIFILM Corporation produces various materials for LCD (liquid crystal displays), OLED (organic light-emitting diode) displays and touch panels, and supply them widely to panel manufacturers, polarizer manufacturers, and touch panel manufacturers. Displays using the materials we supply are used in a variety of products such as TVs, PC monitors, tablet PCs, notebook PCs, smartphones, mobility displays (car monitors, etc.), monitors for industrial equipment including medical devices, and other products. It is exported to the EU countries and widely used as a built-in device or main parts.

PFAS are widely used in display materials. Their applications are wide-ranging, including surface and retardation layer of polarizing films, protective and functional layer of touch panels, protective layer on the outside of liquid crystal cells, color filter formed by color resin and black resin, and interlayer insulation layer of TFT substrates. In these applications, PFAS remain in displays, and the final product exported to the EU contains them. Furthermore, due to their usefulness, PFAS are widely used in display materials, not only by our company, and if PFAS regulation is implemented, the display industry will be greatly affected.

## 3. Roles and Actual Usage of PFAS

### 3.1. Retardation Layer and Anti-Reflective layer

Most LCD and OLED displays have a retardation layer to improve visibility at wide viewing angles, and an anti-reflective layer to prevent external light reflections. The retardation layer and anti-reflective layer of optical films we offer contain trace amounts of PFAS. In many cases, this optical film is applied to polarizing film and used on one or both sides of the display.

#### 1) LCD Retardation Layer:

In TN-mode LCDs, when voltage is applied to the liquid crystal cell that makes up the display, the liquid crystal molecules stand up and the pixel blocks the backlight light, turning black. However, the liquid crystal molecules near the glass substrates at the top and bottom of the cell remain tilted. Therefore, when the display is viewed from an angle, light rays leak out of the display, reducing the contrast and making the image difficult to see. By placing a retardation layer that exhibits special optical properties (optical anisotropy) between the liquid crystal cell and the polarizing film, the leakage of light rays from the oblique angle can be prevented, the contrast can be improved, and images that are close to the front angle can be obtained even at wide viewing angles[*1]. This retardation layer exhibits the desired optical properties by controlling the molecular orientation over a wide area. In order to exhibit such optical properties, it is necessary to add PFAS to the retardation layer, which can promote molecular orientation by being localized just only on the surface and can control the film thickness precisely[*3]. In addition, since it is localized just only on the surface, the required performance can be obtained in an extremely small amount.

#### 2) Anti-reflective Layer in OLED Displays:

In OLED displays, an organic EL layer is formed on the electrode part of the TFT substrate that controls the voltage and current applied to each pixel. The wiring and organic EL layer of this TFT substrate are made of thin metal films and have a high reflectance, so when external light is incident, strong reflected light is generated. This reflected light interferes with the display light from each pixel, making the image difficult to see. In particular, it becomes a big problem when used in a bright room or outdoors. To prevent this, a retardation layer and a polarizing film are placed on the top surface of the organic EL layer and substrate. This retardation layer changes the polarization state of the reflected light, and the polarizing film cuts the reflected light to prevent interference with the display light, greatly improving visibility[*2]. This retardation layer has the property of changing the polarization state of reflected light by arranging and fixing molecules with a retardation in a predetermined direction and achieving a predetermined layer thickness. To this end, it is necessary to add PFAS to the retardation layer, which promotes molecular orientation by being unevenly distributed on the surface and allows precise film thickness control. Moreover, since it is unevenly distributed on the surface, it is possible to obtain the required performance with a very small amount of PFAS.

### 3-2. Touch Panels

The display surface of tablet PCs, smartphones, and car navigation systems is equipped with a touch panel that is integrated with the display. We provide a dry film (DF) material for these touch panels, and the DF material contains a small amount of PFAS surfactant.

DF materials are composed of multiple photo-sensitive coating layers and functional layers that are coated and dried on a film substrate. They are called dry films because they are provided in a dry film form, as opposed to liquid resist materials.

Various touch panel technologies have been devised and commercialized, but the dominant technology for tablets and smartphones is capacitive type. This technology uses a transparent substrate with a transparent conductor to form a transparent electrode, and detects changes in capacitance when a finger is placed close to it. The sensor is formed between the display and the cover glass on the surface of the panel.

Also in touch panels, DF materials are used to provide specific functions such as protecting transparent electrodes. After forming the transparent electrode, this DF material is transferred and patterned by the photolithography process, and the DF material coating is left in the desired position in the final product to function. This DF material is formulated to perform specific functions in the final product. In addition, it is necessary for the final touch panel-display performance to have no adverse effects on the optical properties, appearance, and other optical properties in the display viewing area. For these reasons, this DF material contains a miniscule amount of surfactant in the film coating liquid to improve the leveling of the liquid, achieve coating suitability, and obtain good film smoothness[*3]. Ultimately, it plays an important role in balancing the function of the touch sensor and the quality of the display. A miniscule amount of PFAS surfactants remain in the final product.

### 3-3. Inter-layer Dielectrics in LCD Cells

Our company provides liquid materials for the inter-layer dielectrics that constitutes the thin film transistor (TFT) of the liquid crystal cell to LCD panel manufacturers. This inter-layer dielectrics is a resist material, formed between the wiring electrode layer and the pixel electrode layer, to prevent electrical shorts and interference between the two electrodes. This inter-layer dielectrics is composed of organic materials, and has a low dielectric constant and is capable of forming thick films, so it can effectively reduce electrical interference. This allows for a wider pixel area to be designed, contributing to the realization of brighter displays. This effect is particularly effective in small and medium-sized displays with high pixel densities.

The inter-layer dielectrics requires not only uniform thickness and transparency but also low dielectric constant, corrosion resistance to metal electrodes, heat resistance for subsequent processes (sputtering), and contamination resistance to materials like liquid crystals. The surfactants used in this inter-layer dielectrics are primarily added to ensure uniform thickness and interface adhesion with other layers, and they must maintain the required properties for the inter-layer dielectrics without adverse effects. The surfactants composed of PFAS are the optimal materials for this purpose.

Additionally, PFAS are used as surfactants for the overcoat layer of the functional film on the outer surface of the glass substrate of the liquid crystal cell. This overcoat layer demands properties such as uniform thickness, transparency, corrosion resistance to functional films including metals, low refractive index, and scratch resistance. The surfactants used for this overcoat layer are mainly added to ensure uniform thickness, but they must also maintain the required properties for the overcoat layer without adverse effects.

## 4. Market Size and Socioeconomic Impact

### 4-1. Retardation Layer and Anti-Reflective Layer

Visibility and anti-reflective characteristics in wide viewing angles have become increasingly important as LCD and OLED displays continue to proliferate in various applications. The share of optical films with our retardation layer in OLED displays is approximately 40%, and the impact on the display industry would be significant in the event of PFAS regulation enforcement.

If this regulation is enforced and a transition to alternative substances cannot be achieved within the transition period, the image contrast in wide viewing angle of LCD displays, which are currently used globally, will notably diminish. Reflective light in OLED displays will increase, leading to significantly reduced display visibility. In fields such as automotive and aviation navigation systems, medical applications, and other areas where performance of sensitive LCD and OLED display images is crucial for safety, such levels of performance degradation are by no means tolerable. In displays used in automotive, medical, industrial, and similar applications, reduced visibility leads to misrecognition, misjudgement, and erroneous operation, ultimately resulting in potential life-threatening consequences.

As for our company, the quantity of PFAS used in retardation layer and anti-reflective layer, which are incorporated into displays and imported into the EU, is approximately 0.3 tons per year. The total quantity for all applications, including paper, textiles, firefighting agents, etc., ranges from 140,000 to 310,000 tons per year (based on the 2020 EU market introduction volume and socio-economic analysis of PFAS regulation proposals). The usage in retardation layer and anti-reflective layer is extremely minimal.

As mentioned above, PFAS is extensively used in displays, and considering the significant applications of displays, the impact of this regulation is enormous. It is necessary to consider alternative materials, production applications, long confirmation and approval procedures in each supply chain, and the impact on critical uses such as medical devices and in-vehicle devices.

**4-2. Touch Panels**

Touch panels are integrated into various products such as tablet PCs, smartphones, and car navigation systems, and are widely used and exported across the EU countries. The total quantity of PFAS substances contained within touch panels is unknown. However, capacitive type touch panels account for 93% of touch panels worldwide, and within this, our products containing trace amounts of PFAS make up 11%. The socioeconomic impact of the regulation enforcement would be significant. The quantity of PFAS used in our DF materials and remaining in displays, which are imported into the EU, is approximately 0.05 tons per year. When compared to the total PFAS quantity for other applications (Section 4-1), including paper, textiles, firefighting agents, etc., the usage in DF materials is extremely minimal.

Without an appropriate transition period, significant socioeconomic impacts are expected. On the other hand, the quantity of PFAS substances to be restricted by the regulation enforcement is relatively a small amount.

**4-3. Inter-layer Dielectrics Within LCD Cells**

This inter-layer dielectrics is particularly effective for small and medium-sized displays with high pixel density, and is widely used in smartphones, tablet PCs, automotive displays, and high-definition medical monitor panels.

If this regulation is enforced and a transition to alternative substances cannot be achieved within the transition period, designs without the use of inter-layer dielectrics would be mandated. In high-definition panels with high pixel density, the pixel area decreases, leading to a reduction in display brightness. In medical displays, reduced brightness can induce misdiagnosis during image diagnosis. While increasing the backlight brightness can be considered as a solution, it increases power consumption and has a negative impact on the environment. Especially in mobile use cases, this contradicts fundamental issues like battery life and heat generation, thereby undermining the product's value.

As for our company, the quantity of PFAS used in inter-layer dielectrics materials and incorporated into displays imported into the EU is approximately 0.003 tons per year. When compared to the total PFAS quantity for other applications (Section 4-1), including paper, textiles, firefighting agents, etc., the usage in inter-layer dielectrics materials is extremely minimal.

| Applications | Annual Quantity of PFAS in the EU |
| --- | --- |
| Retardation Layer, Anti-Reflective Layer | Approximately 0.3tons |
| Dry Film (DF) for Touch Panels | Approximately 0.05tons |
| Inter-layer Dielectrics within LCD Cells | Approximately 0.003tons |
| All Applications | 140000～310000tons * |

*See the 2020 EU market introduction volume and the socioeconomic analysis summarized in the PFAS regulation proposal.

Table 1: Annual Quantity of PFAS in Functional Films for Displays in the EU

**5. Risks to the Environment and Human Health**

When manufacturing our products for display applications, PFAS are handled in a shielded manufacturing zone in a clean room, so they are not exposed to the outside environment and does not flow out.

The total quantity of PFAS used for display applications and imported into the EU is minimal, and it is firmly immobilized within components of displays. There is no exposure during product use, and disposal is managed under the EU Waste Electrical and Electronic Equipment Directive (2012/19/EU) within the EU territory. Collection, decomposition, recycling, or appropriate disposal methods are conducted, ensuring minimal environmental impact and negligible effects on human health."

## 6. Difficulty in Finding Alternatives:

### 6-1. Retardation Layer and Anti-Reflective Layer

In the case of retardation layer applications, PFAS's high surface affinity is crucial. Non-fluorinated substances exhibit inferior surface affinity, leading to inadequate smoothness and molecular orientation, thereby degrading the image quality of LCD and OLED displays. In the multiple retardation layers and anti-reflective layers, different compositions of PFAS are used and it is necessary to find substitutes for each. Moreover, alternatives must satisfy desired performance qualities for all aspects needed in retardation layer and anti-reflective layer, not just surface affinity, molecular orientation, smoothness, and water repellency, but also all other qualities necessary for these layers (such as durability and transparency).

In particular, there are very few substances that can control molecular orientation and layer thickness appropriately, stably, and uniformly, so it is extremely difficult to find substitutes for PFAS as additives for retardation layer and antireflective layer. Since the PFHxA regulation Annex XV was proposed, alternatives have been considered, but no alternatives have been realized yet.

Even if a candidate substitute substance is found, it is not only necessary to check the quality of the retardation layer and anti-reflective layer, but also to check the performance of the film with these functions downstream in the supply chain, that is, at polarizing plate processing manufacturers, display module manufacturers, and set manufacturers. It usually takes about 6 years for one cycle to consider alternative materials, and if the process fails at some stage, two cycles of 12 years or more may be required. Additionally, for medical and automotive applications, support is required for at least 10 years after production ends. It should be noted that even if the use of PFAS is permitted for medical device applications, since displays are general-purpose products, there is a risk that they will no longer be produced or supplied as repair parts for medical devices.

### 6-2. Touch Panels

Despite ongoing consideration of alternatives since the proposal of PFHxA regulation in Annex XV, alternatives have not yet been achieved. Our company utilizes several materials and, in some cases, multiple layers of a single material, each requiring appropriate surfactants. Substituting all coating layers is highly challenging. Even if potential alternative substances are identified, the actual replacement requires verification downstream in each customer's supply chain, encompassing touch panels, display modules, and final products. Additionally, generally, electrical products require approximately 7 years of repair part support after end of life (EOL), which extends to about 10 years for automotive applications. If support for repair parts is not taken into account, the lifespan of electrical and electronic equipment will be shortened, which is also undesirable from a sustainability perspective.

### 6-3. Inter-layer Dielectrics within LCD Cells

The inter-layer dielectrics formed on TFT substrates must satisfy not only uniform film thickness and interfacial adhesion but also various characteristics such as transparency and corrosion resistance. PFAS are optimal choice for the surfactants used in this context, and no substitute substance has been identified thus far. Even if a substitute material is found, it is not a simple replacement, and it is essential to adjust the inter-layer dielectrics liquid formulation, examine the process conditions at the panel maker, and confirm the performance and reliability, including downstream set makers.

The supply chain for displays is long, and a long review period is required to confirm the feasibility of substitution at each stage. Examination of alternative materials usually takes about 6 years for one cycle, and if it becomes NG at some stage, it may take 2 cycles of 12 years.

Additionally, for medical and automotive applications, support is required for at least 10 years after end of life (EOL). It should be noted that even if the use of PFAS is permitted for medical device applications, since displays are general-purpose products, there is a risk that they will no longer be produced or supplied as repair parts for medical devices.

### 6-4. Our Opinions

The PFHxA regulation SEAC final opinion released in May 2022 proposed a seven-year transition period for the display field and that regulation allowed fluorine-containing compounds with shorter perfluoroalkyl chain length to be considered. However, if PFAS were to be regulated in its entirety, it would be necessary to search for a new non-fluorine alternative material with performance equivalent to PFAS, which would make the switch extremely difficult. We are currently considering switching to this difficult alternative material at the expense of development costs, but in addition to confirming the required quality and mass-producibility at the material manufacturer, we are also evaluating the long supply chain and conducting customer adoption procedures. Furthermore, it is necessary to consider the point of view of requiring a long-term supply of repair parts. For these reasons, a transition period of 12 years (13.5 years from the date of entry into force) is requested in the field of displays. In addition, we strongly request that a new system be established so that it will be possible to apply for a further extension of the transition period after the end of the transition period. We ask that

ECHA considers new comment systems and processes to extend the transition period in accordance with RoHS exemptions.

*1. LCD Display Screen with PFAS-Containing Retardation layer (Left) / Without PFAS-Containing Retardation layer (Right)

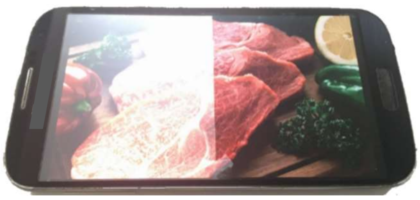
30 Degrees – From the Top

60 Degrees – From the Left

60 Degrees – From the Right

45 Degrees – From the Bottom

*2. OLED Display Screen without PFAS-Containing Retardation layer (Left) / With PFAS-Containing Retardation layer (Right)



*3. Purpose of PFAS Usage

When the surfactant (PFAS) is added, it is unevenly distributed on the surface, and the surface tension becomes constant within the surface, which stabilizes the thickness of the coating layer and improves unevenness.

Drying process