PVTEC
Photovoltaic Power Generation
Technology Research Association

Comments on photovoltaic solar power generation

The Photovoltaic Power Generation Technology Research Association (PVTEC) is an organization in which 18 companies related to photovoltaic power generation in Japan are members, and conducts joint research among related companies. This comment was prepared after hearing not only PVTEC member companies but also non-participating PV-related companies.

[Trends in the solar power generation industry and conventional approaches to PFAS regulations]

While measures for carbon neutrality (CN) are being strongly promoted around the world, photovoltaic power generation is positioned as an indispensable industry and technology for realizing CN.

In Europe, REPowerEU aims to increase the renewable energy ratio to 45% by 2030 and to install 600 GW of new solar power generation by the same year. Japan also aims to achieve CN in 2050, and has set goals to increase renewable energy to 36-38% of total electricity and solar power to 14-16% of total electricity in 2030.

Moreover, at present, at the disposal stage of solar cells, high-temperature incineration has conventionally been carried out, and measures have been taken to minimize the impact of emissions of substances used in solar cells into the environment.

[Current status of PFAS in the solar power generation field]

Solar power generation has a very important role to play in achieving carbon neutrality. The market for solar cells that currently contain PFAS, such as lightweight solar cells and high-reliability solar cells, must expand significantly, and it is essential to have accurate information regarding the use of PFAS.

A. Lightweight solar cell (sheet-type solar cell) module

In order to introduce even larger amounts of solar power generation, which is essential for the European Green Deal, it will be necessary to install it in places with load restrictions or places where good design is required. Further popularization of lightweight and flexible (sheet-type) solar modules is necessary.

The Japanese government has also started a new solar cell development project to solve location restrictions for solar cells.

https://www.meti.go.jp/english/press/2021/1001_005.html

The top sheet (transparent material on the light incident side) of sheet-type solar modules requires a highly flexible, flame-retardant, and highly durable film. In particular, in order to ensure fire safety as a product, there are no alternative materials for the top sheet other than fluorine-based films such as ETFE.

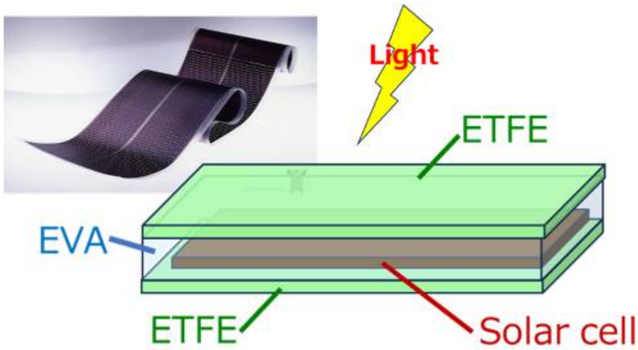

Fig. 1 Lightweight sheet-type solar module

Fluorine-based films such as ETFE are expensive (compared to glass used in non-light solar cells), and many engineers continue to search for alternative materials. However, the current situation is that they have no choice but to use them even though they are expensive.

One of the candidates for alternative materials is PET front coating (as pointed out by ECHA). Materials in which PET film is coated with PFAS or ceramic materials are being considered, but at this stage, data on the flame retardancy and high durability of these materials has not been published, and it is difficult to put them into practical use.

Furthermore, if PFAS is completely avoided in the back sheet of sheet-type solar modules (the side opposite to the light incident side), it will be difficult to ensure durability and fire resistance. Coating with some thickness is inevitable.

In addition, the regulations in the U.S. state of Maine, which have been introduced in advance, leave room for approval through reporting to the authorities, which suggests that they cannot be completely eliminated.

Existing sheet-type solar modules that use fluorine-based films such as ETFE mentioned above have a strong track record in lightweight markets and markets where design is important around the world. It also has a good track record in terms of fire resistance and durability. For this reason, it is considered important as an option for realizing CN.

As mentioned above, the regulation of PFAS on sheet materials that protect the power generation layer of sheet-type solar modules has an extremely low environmental impact, and will have a devastating impact on the spread of sheet-type solar modules, which are expected to expand in the installation area. This has a major impact not only on environmental issues but also on energy security, and there are concerns that it will lead to movements that run counter to the realization of a sustainable society.

B. High reliability solar module

In ordinary solar modules, high reliability over a long period of 20 years or more is achieved by using glass as a weather-resistant material on the light incident side and a back sheet on the side opposite to the light incident side (back side). PFAS is used in this back sheet to increase reliability.

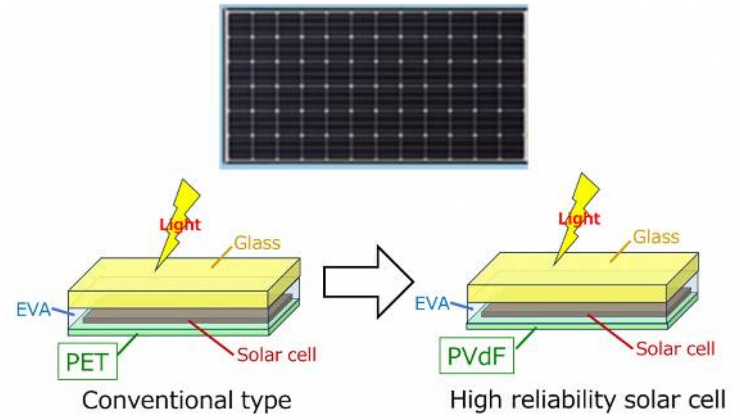

Fig. 2 High reliability solar module

The market for highly reliable solar modules includes markets with harsh conditions such as areas with high temperature and humidity, areas with large temperature differences, areas affected by salt damage, and markets where it is difficult to replace solar modules (such as on the walls of buildings).

PFAS is essential for realizing highly reliable solar modules for the following two reasons.

1) When fluorine disappears, the adhesion with the encapsulant becomes weaker, making it easier for the backsheet to peel off and expose the encapsulant. This shortens the useful life of the panels, increases the frequency of replacement, and leads to an increase in waste.

2) When fluorine is depleted, UV deterioration accelerates and the backsheet is destroyed. Therefore, similar to 1), this leads to an increase in waste due to a decrease in service life.

C. Bifacial solar module

In a bifacial solar module, glass or a fluorine-based backsheet is used as a weatherproof member on the back side. Bifacial solar cells can effectively utilize incident light from both the front and back surfaces, thus achieving high power generation. Since it is used in large-scale solar power plants around the world (80% of large-scale solar power plants in the United States), the impact is significant.

Using glass as the weather-resistant material on the back side makes the module heavier, so there are still no alternative materials for markets with weight restrictions.

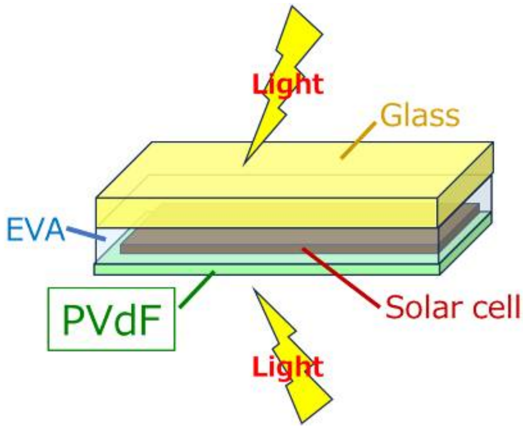

Fig.3 Bifacial solar module

D. Perovskite solar cells (cells)

In order to introduce a large amount of solar power generation, which is indispensable for the European Green Deal, etc., it is necessary to install it in places where load is limited and in places where design is required. As a next-generation solar cell technology, coating-type, highly efficient perovskite solar cells are attracting attention.

Fluorine-based additives are used in many high-efficiency perovskite solar cells to improve the conductivity of the P-type semiconductor.

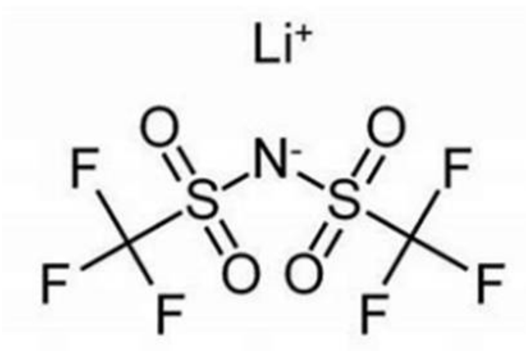

Fig 4 Structure of typical fluorine compounds Lithium Bis (trifluoromethanesulfonyl)imide; LITFSI

(Reference: Literature on perovskite solar cells using this fluorine compound. Its use is reported in many publications on high-efficiency perovskite solar cells.)

Nature volume 616, pages724–730 (2023) ; Controlled growth of perovskite layers with volatile alkylammonium chlorides

SCIENCE, 28 Jul 2022, Vol 377, Issue 6605, pp. 531-534 ; Inactive $(PbI_2)_2RbCl$ stabilizes perovskite films for efficient solar cells

The conversion efficiency is greatly reduced without this fluorine-based additive. Verification of

alternative materials is a future task. In addition to conversion efficiency, the impact on device reliability needs to be evaluated.
(Reference: Comparison of conversion efficiency with and without fluorine compounds. Conversion efficiency was 1.1% without fluorine compounds, but improved to 5.8 to 9.0% by adding fluorine compounds)

E. Solar cell manufacturing process

Fluorine-based materials are also used in the solar cell manufacturing process.
There are cleaning and surface treatment processes that use strong oxidizing chemicals (concentrated nitric acid, high-temperature hydrochloric acid, ozone), and PFAS are used in some manufacturing equipment, piping materials, carrier jigs, etc.
Verification of alternative materials is a future issue. It is necessary to evaluate the effect of elution on the device and its lifespan.
These are similar to the semiconductor chip industry, and we will respond by keeping an eye on developments in the semiconductor chip industry, including considering alternative materials.

F.Cable

Solar power generation systems use cables in addition to equipment such as solar cells and power conditioners. Like equipment, cables must have a long lifespan of 20 or 30 years or more, and fluorine-based materials are used as the covering material.
Cables are not unique to the solar power generation industry, and we will respond while keeping an eye on trends in other industries that use cables, such as considering alternative materials.

[Urge for Exemption and Review Clause]

[Future Steps and Strong Recommendations]

1. Promoting Global Carbon Neutrality

To effectively achieve global carbon neutrality, it is imperative to review the development of alternative technologies and create a well-balanced regulatory timeline. By doing so, we can contribute significantly to the CN goals. For instance, a practical approach would be defining the use cases and clearly outlining the specific items subject to regulation. This strategy will ensure efficient risk management.

2. Strategic Testing and Reporting on Alternative Technologies

Our strategic plan involves conducting thorough tests to explore the potential of alternative technologies. Upon obtaining results, we will present our findings. To illustrate, we intend to produce solar power modules that consist of a non-fluorine backsheet (an alternative material) and an ETFE top sheet (the current material). By subjecting these modules to fire tests and comparing their performance, we can offer a clear outlook on their viability.

3. Immediate Action Needed for Fluorinated Materials

Recognizing the current lack of viable alternatives for fluorinated materials utilized in solar power generation systems and manufacturing processes, we strongly advocate for their exemption from restrictions. Taking into account the time required for alternative material development, it is evident that various stakeholders, including component manufacturers, face challenges such as evaluation, redesign, technical verification, and implementation. As a result, it is critical to monitor the availability of alternative materials continually.

4. Call for Flexibility and Extended Exemption Period

A predetermined derogation period is not practical considering the complex dynamics at play. Therefore, we urge the inclusion of a “review clause” that allows for the extension of the derogation period if it remains uncertain that suitable alternative technologies or materials will be ready by the restriction deadline. Considering the necessary transitional period of at least 10 years and market conditions, it is reasonable to propose a period of at least a decade after the entry into force of the restriction. This duration accounts for the one to two years required for alternative material development, the three years needed for durability and power generation validation in actual exposure environments, and the time essential for various certifications.