

Mass Production Technology for Wet Coated Smart Window/Glass

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Keyword: Smart Window, Smart Glass, Slit Coater, Environment, Building

ABSTRACT

Toray Engineering Co., Ltd. is a company that possesses technology for an integrated production system, with our slit coater as the key component, in order to wet coat material for electrochromic Smart Window. Our technological manufacturing proposal will help realize cost-reduction, high-productivity, glass up-sizing, etc. of the electrochromic smart window.

1. INTRODUCTION

Windows are not only used to confirm or enjoy the scenery outside, but also they become the source of big heat inflow and outflow for the transportation system, such as automobiles, buses, trains, ships, and aircrafts, and for buildings such as commercial facilities, airports, residences, etc.. For this reason, windows greatly impact the insulation of these buildings and vehicles, and thus influencing the comfort and the safety inside. For example, during the summer time, the solar energy introduced inside through the windows require excessive air-conditioning energy for cooling. The opposite also applies during the winter time. Under these situations, as the window is the biggest gateway of solar heat, there is a high demand to suppress the usage of air-conditioner for cooling and heating and as a result reduce the total energy consumption by adopting windows that can freely and precisely control heat (hereinafter referred to as a Smart Window). In this summary, the latest technological trends and issues for Smart Window will be shared, along with the solutions offered by Toray Engineering.

2. Smart Window Market & Technical Trend

Nowadays we find many Smart Windows used in various buildings and vehicles. Among these Smart Windows, electrochromic (EC) Smart Windows that applies electrical voltage to selectively and reversibly control the tint of the glass for insulating effect, is well known. Among them, the most well-known may be the windows adopted by medium passenger aircraft B-787 by Boeing. In addition, the EC Smart Windows are adopted in automobiles, airports, skylights in nursing homes, etc., and these adoptions are expected to further increase in the future. You can observe this trend in the report by a research company (Fig.1). The market for the EC Smart Window for commercial buildings and automobiles are forecasted to more than double the size in 2027.

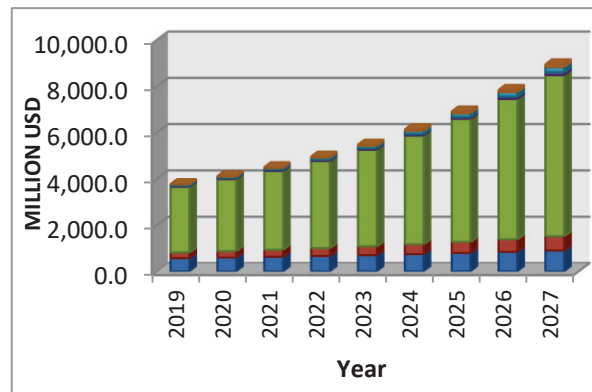


Fig 1 The Global Market for Smart Glass and Windows to 2027 by FUTURE MARKET

The main supplier of these electrochromic glasses include France's leading glass manufacturer, Saint-Gobain, its affiliated company, Sage Electrochromics Inc., an US venture company, View Inc., and Gentex Corporation in US, whose product in air craft window and anti-glare mirror are well-known. Currently these EC glasses are mainly manufactured by depositing necessary layers by sputtering method using vacuum equipment. However due to the high cost arising from its capital investment, productivity, and yields, the research and development are tending toward manufacturing process and material that allow depositing the layer with the wet process rather than the conventional dry process with the sputtering method.

3. Smart Window Technical Issue

Although electrochromic Smart Window has been in the market for over 20 years, it is still far from being widespread. The following are the main issues that need consideration for the spread and mass production of the Smart Window:

- 1) the cost down of the product;
- 2) the establishment of production process for large-area deposition; and
- 3) the promotion of product's aesthetics and durability.

Speaking of 1), the cost down of the product, the biggest bottleneck is the current production method of accommodating the vacuum process for depositing the necessary layers. The extremely high capital investment

cost drives up the price of the product. In addition to that, there is technical limitation in this process from the point of view of material usage efficiency and product yield that prohibits the cost down of the product.

For item 2), to widen the product application in the future, establishing a production process that accommodates larger-sized architectural glasses (over 3m square) becomes mandatory. Moreover, the production of large-sized glasses will enlarge the production of total surface area of the product per each line, and as a result induces reduction of the product cost at the same time.

Lastly for 3), in order to overcome issues related to aesthetics and durability of the product, higher accuracy at each deposition process is required. Since windows are mostly installed at places where users often visualize, any defects or failures in its production process greatly influence the quality and the life durability of the product. The window being a product that is generally not frequently replaced or repaired, the deposition accuracy that withstands at least more than 15 years usage is requisite.

4. Toray Manufacturing Solution for Smart window Mass Production

To tackle above-mentioned issues, Toray Engineering Co., Ltd. proposes wet process manufacturing method and the production equipment that enables the process to realize and contribute to the mass production and spread of the Smart Window.

First of all, the deposition of electrochromic layer and electrolyte layer should use the wet coating method rather than conventional vapor deposition method. This is realized by adopting our highly accurate Slit-Nozzle Coater developed with our exclusive technology (see Fig. 2 for details). This state-of-the-art Coater cuts equipment purchase cost, improve material use efficiency, promotes productivity, and helps to establish a process for large-sized glasses that conventional sputtering process could not realize. Through these contributions, our Slit Coater enables mass-production and market penetration of the EC Smart Window.

Toray Engineering's Slit-Nozzle Coater is an equipment that boasts over 700 units sales record in LCD color filter field where requirements against deposition accuracy is extremely strict. However our product line-up is not only limited to this Slit-Nozzle Coater. In addition, as you see in Fig. 3, we possess technology to cover total line production management system, starting from the acceptance inspection of the glasses, cleaning, deposition, drying, and laser patterning to ITO/TCO layer.

Our integrated technology will enable proposal and support of our user's production line which will surely help to reduce some of the current and expected loads and obstacles that EC Smart Window manufacturers are facing. We are committed to utilize our wide experience

as an Engineering Company to help design an integrated line for the entire Smart Window production facility.

5. CONCLUSIONS

Toray Engineering Co., Ltd. is committed to contribute to global energy conservation through spreading smart window worldwide by providing our technology to the production process of the EC smart window that has wide range of usage not only for the residential and commercial buildings but also for the applications such as automotive, aerospace, and trains etc..

REFERENCES

- [1] FUTURE MARKETS "The Global Market for Smart Glass and Window to 2027"
- [2] QYResearch "Global Automotive Auto Dimming Mirror Market Insights, Forecast to 2026"

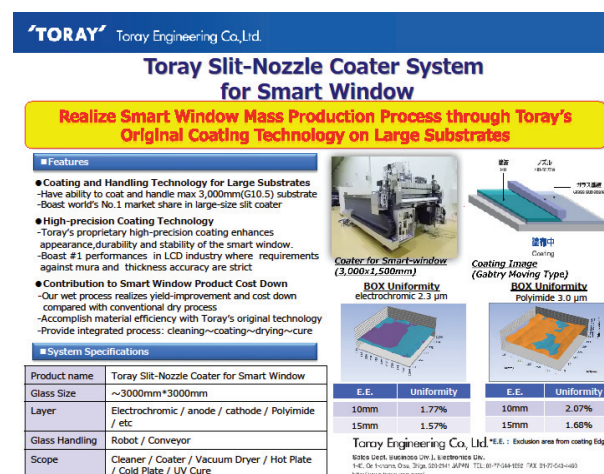


Fig 2 Toray Slit-Nozzle Coater System for Smart Window

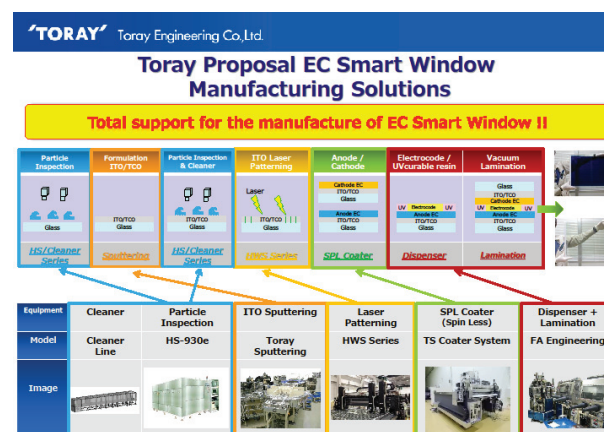


Fig 3 Electrochromic Smart Window Manufacturing Solution