Rethinking of sputtering process – partial coating technology

Author

Jukka Vuoristo

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Contact

Jukka Vuoristo
Chief Technology Officer, Inventor of patented partial processing method
Volframi Oy Ltd
jukka@volframi.com
+358 45 120 9773

Abstract

Coatings are an emerging technology for the fast-growing glass market. Various thin film deposition technologies have been used for decades in glass processing industry to improve the properties of glass or to add new functionalities.
This paper aims to rethink the process to enable an easier, cheaper, and more feasible method to process partial coatings on large substrates, which in turn allows various new innovative products for the smart glass market in the construction, transportation, and power generation industries.
In the new coating method, the vacuum chamber size does not depend on the size of substrates, i.e., a small chamber can be used to create targeted thin film coatings on very large substrates. The deposition process itself is based on the well-known PVD processes like magnetron sputtering. The coatings can be created on a substrate without coating the entire surface, which is very advantageous when creating mechatronic features, such as control switches on a large glass pane. There are no limitations on the size of the pane and the same tool is suitable for all pane sizes. The new method reduces the total process time and target material usage and also minimizes process steps. Furthermore, the tool footprint is small. The new partial coating method makes coating of small areas more feasible by reducing investment and processing costs. The benefits mentioned above tackle the biggest barriers for the use of sputtering process in mechatronics of smart glass products.

Introduction

There is an increasing need to bring functionalities on glass surfaces in the construction, transportation, and power generation industries. Thin film coatings are an emerging way to improve properties or add new functionalities in the glass processing industry. However, the pace of innovation is being held back by the demanding requirements in glass processing, including large facilities to house big, expensive machinery for each of the different processes.
The core of the innovation is in a completely new way of handling glass that allows targeted processes on the glass surface without processing the surrounding area. The tool can be used to conduct a number of processes that previously could not necessarily be conducted on a large sheet of glass or were not practical due to cost reasons. Magnetron sputtering was selected as the first process to be developed. It allows, for example, the production of different conductive patterns and transparent applications on a substrate. The tool can be operated using only a single or multiple chambers depending on the application and number of materials.
The partial coating method makes coating possible in an ordinary glass factory and provides opportunities to create completely new products, which can lead to new business opportunities. It provides several benefits and more sustainable processes. These benefits are critical if we want glass coatings over small areas to become more common on large glass surfaces. The partial coating process provides new opportunities for designers and architects as well as for companies to manufacture new products at reasonable prices for their customers.

New method for targeted partial processing for sputtered coatings

A partial sputtering coating process is based on a novel magnetron sputtering technique. Generally, the use of this technology requires a high level of expertise, clean facilities, and experience in the use of the process. A partial coating process differs from the traditional way in certain essential respects. Thus, the use of a coating tool becomes possible without deep technological knowledge under normal glass factory conditions. This means that expensive clean room facilities are not automatically needed. Of course, the film quality requirements set the final limits for environmental variables.
The presented new method for processing of partial coating is based on a proprietary novel chamber design and process algorithms. Instead of placing the whole substrate inside a vacuum chamber, the chamber is split into two vacuum chamber sections, and the substrate is placed inside the gap between them so that only for the surface to be processed is covered with the chamber. One vacuum chamber has a sputtering arrangement and a mask, and the other has a substrate surface heater. The side of the substrate plate on which the conductive patterns are to be formed is placed towards the sputtering arrangement while the other side faces the substrate surface heater. During the sputtering process, the pressure is equal in both vacuum chambers. The tool can be turned in different positions, so the tool can receive substrate plates at different inclinations from vertical to horizontal.
Meanwhile, the partial coating process is optimized for "rough needs", such as creating conductive areas when the pattern is simple, and the width of the line does not need to be very precise. The accuracy of coated patterns can be in mesoscale from 0.1 mm to millimeters. So far, there has been no need for more accurate patterns that could however be achieved. If there is a mask between the substrate and the target (the sputtering source), patterns can be formed on the substrate simultaneously. In the partial coating process, multiple films may be run by repeating the process with different source targets, meaning it can be using multiple source materials and patterning at the same time. If fine edges or complex pattern designs are required, traditional patterning and etching processes are necessary. These processes can be performed on the same tool with other process chambers.

Partial coating process with several advantages and benefits

Customer's need for coated glass can place many challenges on glass processing manufacturers. The cost of coating equipment, difficulty of the process and requirement for clean rooms have been the biggest barriers to the spread of the coating process in the glass

industry. Typically, thin film coating is seen to mean higher costs and to be too demanding and high-tech for normal manufacturing environment. This is because conventional thin film processing methods are not suitable and feasible for processing large glass panes used in construction industry. Thus, there is a clear need for new methods and solutions to overcome the manufacturing problems and to improve the profitability of the processing steps. The presented new partial processing method addresses these needs and enables easier, cheaper, and more feasible processes for large glass panes, when only a designed area needs to be coated.

As we know, in the flat glass industry, especially in the window industry, each pane can be of different size. What is exceptional in this method is the new way of handling glass sheets; there is no need to take the sheet inside the tool, only the desired part of the surface is processed. As a result, compared to the existing way, a partial processing tool is considerably smaller in size and consumes less power. In addition, production has fewer steps, and the processes consume less source materials. Small tool size reduces the space required and makes it easier to move. Furthermore, several tools can be used as parallel modules in the same production line. There are no restrictions on the direction of use of the tool. The whole partial process is simpler, faster, and more efficient.

Initially, the partial coating tool and method were designed to form conductive patterns on a surface of substrate plate by a sputtering process. It is possible to further develop the tool to manufacture many different processes for different purposes. That is why there is no one-size-fits-all partial coating tool as the configuration depends on the performance, desired application, and production requirements, which are unique. The important aspect in this process is that coating small areas is more sustainable. All in all, the partial coating method has many features that can improve substrate performance or create unprecedented applications.

Applications and functionalities

The partial coating method has many features that can improve substrate performance or create completely new applications in, e.g., smart glass surfaces of all sizes. In the construction glass industries, including internal glass construction, architectural glass in windows and other glazing systems, there are a variety of possible applications that can be created by partial coating, such as

- integrated systems, e.g., touch sensitive controllers
- sensors, e.g., temperature or moisture sensing
- detectors, e.g., a glass breakage sensor
- conductive areas, e.g., a bus bar or conductor areas for transparent solar panels
- tactile coatings, e.g., sensible markings on a glass
- functional coatings, e.g., heated areas in a windshield.

There may also be other needs for partial coating not yet recognized. The development of partial coating is still in progress. The future is extremely fascinating; we will have more autonomous and flexible systems in the future. Early next year, there will be more accurate results when the process development work will achieve its peak. The method will be tested, various functionalities will be developed, and more precise specifications will be established for the use of the glass processing industry. We will also see the first end-products installed in place and in use. This will provide important information for development work and product design.

Conclusions - Unprecedented flexibility in producing functional glass panes with targeted processing

The partial processing method is a radical innovation. What is exceptional in the method is that there is no need to take the glass sheet inside the tool, only a desired part of the surface is processed. As a result, in case of partial coating, the tool is considerably smaller in size as well as in its footprint compared to the existing way. It also provides several benefits and more sustainable processes. It consumes less power, energy, and gas. In addition, the production has fewer steps, and the process consumes less material. The whole coating process is simpler, faster, and more efficient. This makes coating possible in an ordinary glass factory and provides opportunities to create totally new products, which can lead to new business opportunities.