

FREQUENTLY ASKED QUESTIONS

1. **What is electrochromic (EC) glass?**

It is electronically tintable glass that can be switched from clear to darkly tinted (and from darkly tinted to clear) at the push of a button. EC glass can be operated manually or integrated into an automated building management system. EC glass modulates visible light transmission and solar heat gain, and, in the tinted condition, blocks 98% of the total solar radiation that causes fading.

2. **How does EC technology work?**

EC panes are coated with five layers of ceramic materials, which have a total thickness that is less than 1/50th that of a human hair. When voltage is applied across the coatings, ions travel from one layer to another layer, where a reversible solid-state change takes place, causing the coating to tint and absorb light. Reversing the polarity of the applied voltage causes the ions to migrate back to their original layer, and the glass returns to its clear state.

3. **How is the Glass manufactured?**

Conventional float glass is coated with layers of metal oxides using a vacuum deposition process called "sputtering," which is the same process used to make hundreds of million square feet of low-e and double low-e glass each year. The coated EC pane is then fabricated into an insulating glass unit (IGU) with another piece of glass (clear, tinted or laminated) and a stainless steel spacer.

4. **Are there intermediate tint levels?**

The standard control systems currently provided switch the glass from its clear state to its tinted state and vice versa. Intermediate state controls will be offered as a standard feature in 2008, and possibly sooner. In the interim, we can provide individually designed and engineered intermediate state control solutions generally for larger projects at an additional charge.

5. **What control system options are available?**

The EC product is supplied with a standard panel-mounted control system. This control system can be operated by the user via a simple wall switch or integrated into a variety of different building management control systems, such as lighting, energy management, audio visual and security systems. When integrated in such a manner, EC windows and skylights are controlled by inputs from, for example, timers, light sensors, motion sensors, lighting control and thermostats.

6. **Can EC products be controlled wirelessly?**

Yes, many building management control systems—into which EC products can be integrated—have remote control capabilities.

7. **Can EC be powered with photovoltaics (solar cells)?**

Yes, PV-powered EC IGUs are under development. Because of their low DC voltage and power consumption, and the obvious complementary relationship between the amount of sunlight available and the level of tinting required to modulate it, EC products are excellent candidates for PV power.

8. **How fast does the tint level change?**

Most of the tinting occurs in 3-5 minutes, depending on glass size and temperature of the glass. Faster tinting can occur in smaller panes and/or warmer temperatures.

9. **What colors are available?**

EC IGUs come in four standard colors (the colors are a function of the inboard lite): Classic, See Green, Cool View Blue and Clear as Day Gray. EC products can also be ordered with a custom inboard lite, which can be of a chosen color, laminated, fritted, or in other ways non-standard. Please note that the differences among the colors can be seen in the light transmitted into the space, whereas the exterior reflected color varies little, no matter what color the EC IGU is. This is because the coated EC pane is the outboard lite in the IGU.

10. What is the uniformity between panes? Will they all look the same?

As with any coated glass, there will be small color and tint level variations. In addition, the electrochromic technology is not as mature as other solar control and spectrally selective coatings on the market today; therefore, pane-to-pane uniformity relative to conventional static coatings may show an additional level of deviation. More importantly, the inherent dynamic nature of EC products implies that different panes may be deliberately placed in different states (clear versus tinted) and will therefore have a different appearance while providing a desired benefit. The unique dynamic nature of EC products and the significant energy and comfort benefits derived from its changeability (adaptability) suggest that conventional forms of comparison may not always be appropriate.

11. Can you match the EC colors with the color of other glass in the building?

Two pieces of glass from different sources rarely match exactly. If glass from two sources is installed in separate areas of the building, a slight mismatch is often unnoticeable. If there is not a separation on the building between the two types of glass, the EC product can be ordered in a color that is complementary to the other glass products being used in the building.

12. What is the largest available size of EC products?

The largest size currently available is 42.5" x 60" (1,07 m x 1,50 m) (in either dimension, W x L, or L x W).

An important point to keep in mind with EC products is that they allow for tinting of the glass to be controlled in zones, which is desirable because the sun's glare is directional. This introduces the opportunity to design with glass in such a way that it can be programmed to "track" the sun as it moves around the building. In this scenario, smaller panes can be desirable by providing more zones of control within a given glazing area. The greater the number of zones, the greater the opportunity to optimize and balance glare, daylighting and energy issues.

13. How does the cost compare to low-e insulated glass?

Because in most installations, EC products eliminate the need for interior and exterior blinds and shading systems, glass-to-glass price comparisons are not appropriate. The reduction of other costs must also be considered given the unprecedented benefits provided by the EC product. Until now, glass and its necessary solar control devices were two different things. With EC products, the glass IS the solar control device. Moreover, EC products conserve energy and reduce first costs (smaller HVAC systems, for instance, can be used in many situations). Building maintenance costs are also lower because HVAC systems run less often, and there is no need to replace or repair shades and blinds. Thus, when the higher initial cost of EC glazing is balanced with the reduced facilities and operating costs, the result can be a neutral impact on the project budget and in some cases could create cost savings. Like many breakthrough products EC technology initially carries a premium price. Importantly, the EC IGU product lends itself to strong processing efficiencies and economies of scale. EC product is in the early stages of growth and cost reductions, not unlike the cost history of low-e, flat panel displays and cell phones. As the market becomes aware of the many benefits of EC products, and volumes increase, The Manufacturer is setting up for a 60-70% cost reduction over the next five years, and then a further cost reduction of 30-40% over the following five years. During this time the product performance and features will advance as well, including wireless installation and controls.

14. What happens when a building has a power outage?

When power is removed, EC products gradually revert to the clear (untinted) state.

15. Do EC products provide privacy?

EC products provide some privacy because they transmit less than 4% of the visible light in their tinted state. On a sunny day, when the windows are in their tinted state, it is nearly impossible to see through the glass when looking in from the outside. However, the purpose of EC windows and skylights is to provide solar control without blocking the view from the interior to the outside— therefore even in their tinted state they are transparent (unlike "privacy glass" which turns opaque) so they do not provide 100% privacy. For example, at night, when the lights are on inside the building, someone on the outside could see distinct images on the inside, even when the windows are in their tinted state.

16. Can you manufacture different shapes?

Yes, custom shapes are available, although they cost more than standard sizes. Shapes other than trapezoids and triangles will be available late in 2007.

17. Do EC windows and skylights help attain LEED credits?

Yes, EC products provide an additional tool for daylighting design and also conserve energy.

18. Where have EC products been installed?

EC units have been sold for residential and commercial applications in VELUX skylights since 2003. There are also a rapidly growing number of commercial projects where EC products are installed.

19. What is the dynamic range of the glass?

EC Classic IGU can be varied from 62% visible light transmission in its clear state down to 3.5% in its tinted state, with a solar heat gain coefficient that varies from 0.48 on the high end to 0.09 on the low end.

20. Where is the EC coating?

In the majority of applications, it is on surface two (the inside surface of the exterior lite). In this location, the EC coating blocks solar heat before it ever gets inside the building, which means there is significantly less heat that needs to be removed by the HVAC system. By contrast, shades and blinds do not block heat from entering buildings. A building occupant might not feel heat directly on him or her if the shades are drawn, but the heat still gets in and must be removed by air conditioning.

21. What is the lead time for EC products?

Lead time will vary due to a variety of factors, but typically 12 to 16 weeks.

22. Are EC products considered "low-emissivity"?

Yes, the EC coating has a low-e surface so it provides all of the advantages of a spectrally selective low-e (even in its clear state). The low-e properties also reduce thermal heat loss during the winter.

23. What are the EC system power requirements?

EC products consume little power. It takes less electricity to power and control 1,500 square feet (approx. 140 sq. meter) of EC glazing (approximately 100 windows) per day than it does to power a 60-Watt light bulb.

24. Has EC technology been tested? How durable is it?

EC technology has undergone rigorous performance and durability testing both in-house and through independent third parties including the U.S. Department of Energy (DOE) and leaders in the glass fabricating and OEM skylight industry. EC IGUs were the first and only products to pass the ASTM E-2141-06 (Standard Test Methods for Assessing the Durability of Absorptive Electrochromic Coatings on Sealed Insulating Glass Units). In fact, the EC technology survived over 100,000 cycles of accelerated environmental durability testing, which is twice the test standard and equivalent to switching a window nine times per day for 365 days/year over a 30-year lifetime, according to the DOE's National Renewable Energy Laboratory.

25. Is there a warranty on EC products?

The manufacturer warrants the EC IGU for up to 10 years depending on the building application; the electronics and electrochromic functionality carry a five year warranty.

26. What happens if a EC pane gets broken?

EC IGUs are easily replaceable. If the glass gets broken, it can be deglazed just as ordinary glass is, and simply unplugged. A new IGU can be installed and reconnected to the low-voltage wiring via a simple snap connector, which resides in the glazing pocket.

27. What framing systems can be used with EC IGUs?

Most frames that use hollow aluminum extrusions and wood window systems will accept EC IGUs. We recommend providing a 5/8" perimeter coverage on the glass, and sufficient room in the glazing pocket to accommodate the slimline snap-together connector.

28. Are there any commercially available switchable technologies for exterior solar control building applications other than EC products?

The EC product is the only one to have passed the stringent ASTM E-2141 standard for windows (please see question number 24).

29. What are appropriate applications for EC products?

EC products are used in residential and commercial windows and doors, skylights and curtainwalls—anywhere there is a desire to bring in natural daylight while maintaining a comfortable interior environment and an uninterrupted view and connection to the outdoors. EC products also conserve energy and are appropriate in green-designed buildings. Moreover, EC products block transmission of 98% of all of the radiation (both visible and ultraviolet) that cause fading, making them highly suitable for applications where the protection of the interior is desired.

The following list highlights some applications that lend themselves particularly well to the EC glazing solution:

- Green or LEED buildings
- Owner occupied office space
- Museums and libraries
- Health care
- Religious facilities
- Atrium, skylights, and overhead glazings
- High-technology or image buildings
- Aviation facilities