

WINDOW PRODUCTS AND ENERGY PERFORMANCE

PAYING ATTENTION TO THE DETAILS OF COMPONENTS AND THEIR MANUFACTURE MAKE A DIFFERENCE

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Windows are manufactured building products. Like all such products, there can be similarities between manufacturers as there are certainly some differences. When comparing or selecting the best windows for a particular building project, the key is to look closely at the details of the materials used, the type of window, and the quality of their construction. This will benefit everyone involved (i.e., designer, builder, owner) by helping to assure that the selected windows provide the right degree of energy performance, durability, visual characteristics, and aesthetic appeal not only when first installed, but over the life of the building as well.

The two primary components in a window product are the glass and the window frame, including the operable sash, which surrounds the glass. Each of these components can vary in the way they are fabricated, treated, finished, and joined together. Those variations impact not only the way the finished windows look, but how they perform too. Here are some of the specifics that are worth paying attention to in the context of energy performance.

THE GLASS

There are only a handful of companies in the world that manufacture glass, so all window companies purchase glass in bulk directly from one or more of those companies. They then cut, treat, and assemble the glass into the finished window product. Some of the variations in glass include the following:

INSULATING GLASS UNITS (IGU)

Window manufacturers assemble glass into their products, usually first by responding to the requirements of energy codes and standards for performance. That usually means that at least two or sometimes three layers of glass need to be fabricated together to form an insulating glass unit (IGU). The panes of glass are separated around the entire perimeter using spacers made of either stainless steel or nylon. While the nylon spacers are sometimes seen as a bit more energy efficient, the stainless-steel spacers tend to be more durable and hold up better over time. The air space between the panes may be replaced with an inert gas such as argon which improves energy performance by slowing the movement of heat in and through the air space. If coatings on the glass are used, they are most commonly applied to the surfaces of the glass facing into the sealed air spaces, although some pyrolytic coatings may be placed on the outside.

GLASS TYPES

Several different types of glass are commonly used in residential and light commercial window products with all types readily incorporated into IGUs.

- **FLOAT GLASS**

The term “float” refers to the manufacturing process in which molten glass is floated atop a pool of liquid tin in order to establish uniformly flat surfaces. Float glass is available as clear, low-iron (in which the trace green tint of clear glass is reduced) or a range of tinted colors. Different thicknesses of float glass are available.

- **ANNEALED GLASS**

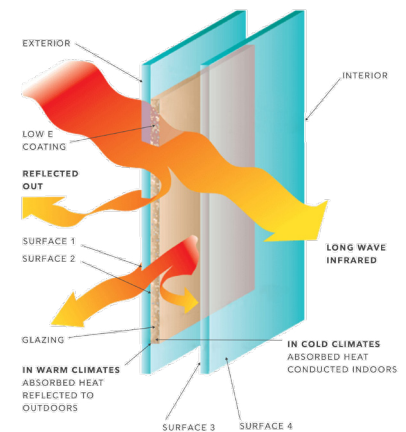
All float glass is initially produced as annealed, meaning that the glass is slowly cooled to room temperature with a minimal final level of residual stress. Annealed glass can be readily cut during the window fabrication process.

- **COATED GLASS**

During float glass manufacturing, pyrolytic coatings can be incorporated into the glass by depositing microscopically thin layers of metallic oxides in one of two ways. A process known as chemical vapor deposition (CVD) produces a hard and durable pyrolytic surface which is fired at over 640°C (1200°F). Alternatively, a somewhat less durable sputter coating can be applied which is a low-pressure technique that deposits coatings using physical vapor deposition (PVD), typically without applied heat. The coatings are designed to enhance or alter the way light and heat pass through the glass and can be formulated for things like low emissivity, solar control, low reflection, and even self-cleaning properties. Note that coatings of any type may change the color of the glass slightly, but not enough to be a deterrent from using it.

- **LOW-E GLASS**

This common type of coated glass reduces the emissivity of the glass surface, meaning the glass provides greater insulation by reflecting heat back towards its source. It can also be designed to absorb or reflect solar energy. As such, low-e coatings are useful for reducing both solar heat gain and building heat loss. For context, uncoated glass has a typical emissivity of 0.84 while Low-e coated glass could have an emissivity of 0.15. This means only 15 percent of heat is absorbed and re-emitted while the rest is reflected.



Some specialty glass is also available and may be used as needed in particular building applications.

- **HEAT-STRENGTHENED GLASS**

Heat-strengthened glass is approximately twice as strong as annealed glass and may be appropriate in some situations for added safety. It is produced by a heat treatment where the temperature of the glass is gradually elevated to around 1300° F, and then the surfaces of the glass are rapidly cooled in order to develop permanent compressive stresses at the glass surfaces.

- **TEMPERED GLASS**

Tempered glass is also sometimes referred to as “safety glass” since it breaks into small, rounded pieces when shattered. It is often required by code in large windows or when the window extends close to the floor. It is heat-treated in the same manner as heat-strengthened glass, except that the quenching process is intensified in order to develop higher residual compressive stresses. While tempered glass is approximately four times as strong as annealed glass, it needs to be manufactured in sizes to fit windows since it is difficult to cut and fabricate.

- **LAMINATED GLASS**

For full safety and security purposes, laminated glass may be used which consists of 2 or more plies of glass bonded with an interlayer material, most commonly polyvinyl butyral (PVB). This is the same type of glass commonly found in car windshields which keeps shards of glass together in case of impact or breakage. It can also reduce noise transfer through the glass and can be readily fabricated by a window manufacturer.

Other types of specialty glass are also available, including glass that is designed to be sensitive to wildlife such as birds and sea turtles. Some localities require such glass, and some building owners seek to have it incorporated for environmental reasons.

Overall, the combination of glass type, coatings, spacers, inert gas filler, and number of glass layers all impact the overall performance of the glass in windows. Most window manufacturers offer several standard combinations and provide the corresponding test results to help in the final selection and specification of glass in a window. For any custom or special circumstances, it is best to collaborate with a window manufacturer to verify options, availability, and pricing of products. Determining which glass options are best suited to a project is usually an iterative process that balances the look, size, location, and performance of the glass with the other components of a window product.

THE WINDOW FRAME AND SASH

The pride of many window manufacturers is the design and fabrication of the component pieces of window that first surround the glass (i.e., the sash) and second, create the finished product to install into a building (i.e., the frame). This certainly speaks to the appearance and aesthetics of any given window product, but it also directly affects the overall performance in terms of energy efficiency, air leakage, and human comfort. Some of the options in this regard include the following:

- **WINDOW TYPES**

Most manufacturers offer several different types of windows such as double-hung, casement, awning, sliding, etc. They each have their own aesthetic and tend to be selected in order to match the overall building style (e.g., traditional, contemporary, modern, etc.) Some tend to seal better against air leakage than others. For example, compression seal products like awnings and casements will generally perform better than sliding sealed products like double-hung and sliders. This performance varies between manufacturers, of course, so test results should be reviewed. Note that European window types include a combination “tilt-turn” type which opens inward to a building along the long or short edge as selected by the user. They are fabricated very differently than windows made in the US and are difficult to compare on a performance basis.

- **FRAME AND SASH MATERIALS**

The material that the sash and frame are made out of can vary significantly in both appearance and performance. Wood has been the traditional choice, particularly in residential designs, which is generally attractive but needs ongoing maintenance to keep the wood durable. Aluminum is a durable alternative but does not provide the energy performance or condensation control in the frame that is usually required. Vinyl has become a popular choice, including fiberglass reinforced vinyl, since it generally overcomes the performance shortcomings of wood or aluminum, although their aesthetic is not universally accepted, particularly for higher end homes. However, not all vinyl is created equal, and some vinyl windows are not as durable over time - they may become brittle or may sag out of shape.



All fiberglass window with Low E2 coating

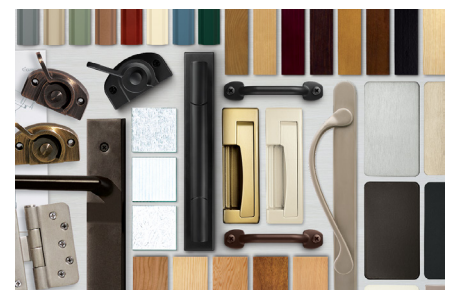


Fiberglass window with wood interior and Low E1 coating

An alternative is provided in window products that combine wood interiors with aluminum clad or fiberglass exteriors thus combining preferred aesthetics with superior energy performance and durability. Some manufacturers include different species of wood (i.e., Douglas fir, white oak, Mahogany, etc.) which can be denser and longer lasting than others and also provide different appearances and colorations. It is always best to check with manufacturers for their standard and optional offerings.

- **PRE-FINISHED OPTIONS AND COLORS**

Different window manufacturers offer different finish options for the frame and sash materials. On the exterior, the choices will be directly related to the material and the ability to produce a quality, durable finish following industry standards. Interior wood materials may be unfinished (ready for site finishing) or pre-finished with paint or stain.



Examples of various window and door hardware and interior and exterior finishes

- **GASKETS**

The seal of an operable window is often dependent not only on the quality of the craftsmanship of the window components and their assembly, but also the quality of the gaskets and weatherstripping used. Some need to be thin to fit into tight spaces and others can be thicker to fill any voids more completely. In all cases, the gaskets need to be durable to hold up over time and repeated use. In the event of damage or deterioration, they should also be easy to replace.

- **HARDWARE**

The hardware for operable windows is similarly varied by manufacturer. While the functionality of the hardware is essentially the same between one manufacturer and another, the style, color, and finish of that hardware can vary considerably. Some offer multi-point locking hardware on selected products which provides a greater degree of security. The hardware can also play an important role in sealing sash together such as on a double hung or sliding type of window. Therefore, it should be assessed for its effectiveness in that regard as well as its aesthetics.



Double-hung window with sash lock hardware.

CONCLUSION

There are choices and variations in the way different window products are made. By paying attention to the details discussed here, the most appropriate choices can be made to suit the needs of any given building project.

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