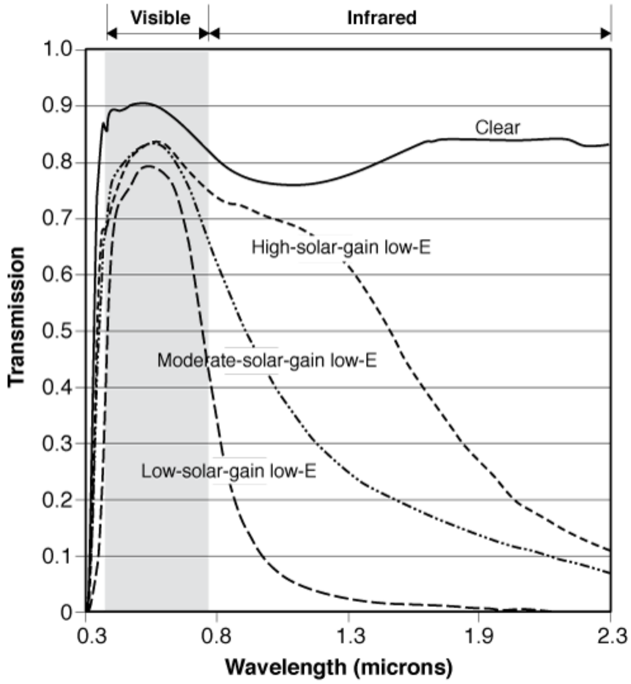
Window Technologies: (technologies.php) Low-E Coatings

When heat or light energy is absorbed by glass, it is either convected away by moving air or reradiated by the glass surface. The ability of a material to radiate energy is called its emissivity. All materials, including windows, emit (or radiate) heat in the form of long-wave, far-infrared energy depending on their temperature. This emission of radiant heat is one of the important components of heat transfer for a window. Thus reducing the window's emittance can greatly improve its insulating properties.

Standard clear glass has an emittance of 0.84 over the long-wave portion of the spectrum, meaning that it emits 84% of the energy possible for an object at its temperature. It also means that 84% of the long-wave radiation striking the surface of the glass is absorbed and only 16% is reflected . By comparison, low-E glass coatings can have an emittance as low as 0.04. Such glazing would emit only 4% of the energy possible at its temperature, and thus reflect 96% of the incident long-wave, infrared radiation. Window manufacturers' product information may not list emittance ratings. Rather, the effect of the low-E coating is incorporated into the U-factor for the unit or glazing assembly.

The solar reflectance of low-E coatings can be manipulated to include specific parts of the visible and infrared spectrum. This is the origin of the term spectrally selective coatings, which selects specific portions of the energy spectrum, so that desirable wavelengths of energy are transmitted and others specifically reflected. A glazing material can then be designed to optimize energy flows for solar heating, daylighting, and cooling.

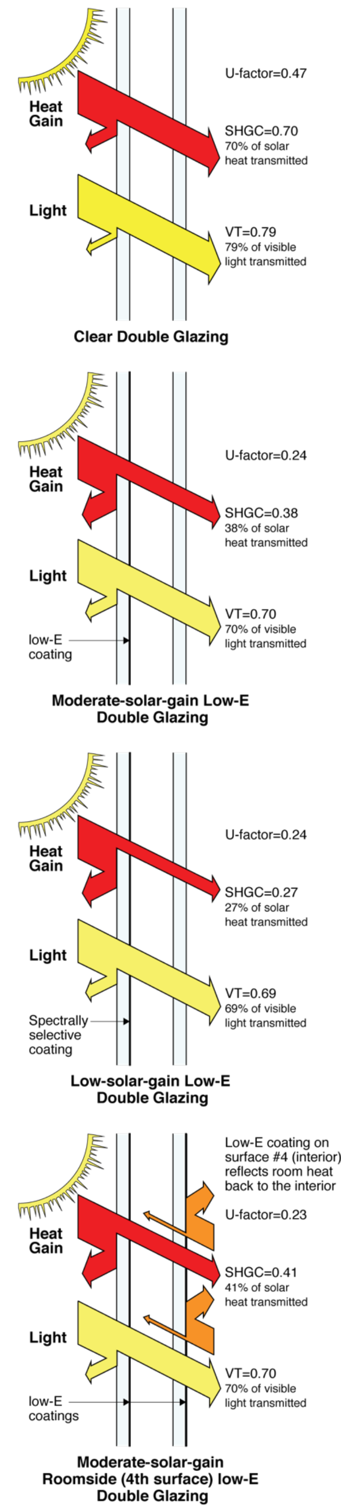


Spectral transmittance curves for glazings with low-emittance coatings (Source: Lawrence Berkeley National Laboratory).

With conventional clear glazing, a significant amount of solar radiation passes through the window, and heat from objects within the space is reradiated back into the glass, then from the glass to the outside of the window. A glazing design for maximizing energy efficiency during underheated periods would ideally allow all of the solar spectrum to pass through, but would block the reradiation of heat from the inside of the space. The first low-E coatings, intended mainly for residential applications, were designed to have a high solar heat gain coefficient and a high visible transmittance to allow the maximum amount of sunlight into the interior while reducing the U-factor significantly. A glazing designed to minimize summer heat gains, but allow for some daylighting, would allow most visible light through, but would block all other portions of the solar spectrum, including ultraviolet and near-infrared radiation, as well as long-wave heat radiated from outside objects, such as pavement and adjacent buildings. These second-generation low-E coatings still maintain a low U-factor, but are designed to reflect the solar near-infrared radiation, thus reducing the total SHGC while providing high levels of daylight transmission (see figure to the right).

Low-solar-gain coatings reduce the beneficial solar gain that could be used to offset heating loads, but in most commercial buildings this is significantly outweighed by the solar control benefits. In commercial buildings, it is common to apply low-E coatings to both tinted and clear glass. While the tint lowers the visible transmittance somewhat, it contributes to solar heat gain reduction and glare control. Low-E coatings can be formulated to have a broad range of solar control characteristics while maintaining a low U-factor.

There are two basic processes for making low-E coatings—sputtered and pyrolytic. Sputtered coatings are multilayered coatings that are typically comprised of metals, metal oxides, and metal nitrides. These materials are deposited on glass or plastic film in a vacuum chamber in a process called physical vapor deposition. Although these coatings range from three to possibly more than thirteen layers, the total thickness of a sputtered coating is only one ten thousandth the thickness of a human hair. Sputtered coatings often use one or more layers of silver to achieve their heat reflecting properties. Since silver is an



Center-of-glass values of double pane units with and without low-E coatings.

inherently soft material that is susceptible to corrosion, the silver layer(s) must be surrounded by other materials that act as barrier layers to minimize the effects of humidity and physical contact. Historically, sputtered coatings were described as soft-coat low-E? because they offered little resistance to chemical or mechanical attack. While advances in material science have significantly improved the chemical and mechanical durability of some sputtered coatings, the glass industry continues to generically refer to sputter coat products as "soft-coat low-E."

Most sputtered coatings are not sufficiently durable to be used in monolithic applications; however, when the coated surface is positioned facing the air space of a sealed insulating glass unit, the coating should last as long as the sealed glass unit. Sputtered coatings have emittance as low as 0.02 which are substantially lower than those for pyrolytic coatings.

A typical pyrolytic coating is a metallic oxide, most commonly tin oxide with some additives, which is bonded to the glass while it is in a semi-molten state. The process by which the coating is applied to the glass is called chemical vapor deposition. The result is a baked-on surface layer that is quite hard and thus very durable, which is why pyrolytic low-E is sometimes referred to as "hard-coat low-E." A pyrolytic coating can be ten to twenty times thicker than a sputtered coating but is still extremely thin. Pyrolytic coatings can be exposed to air and cleaned with traditional glass cleaning products and techniques without damaging the coating.

Because of their inherent chemical and mechanical durability, pyrolytic coatings may be used in monolithic applications, subject to manufacturer approval. They are also used in multi-layer window systems where there is air flow between the glazings as well as with non-sealed glazed units. In general, though, pyrolytic low-E is most commonly used in sealed insulating glass units with the low-E surface facing the sealed air space.

Low-solar-gain low-E coatings on plastic films can also be applied to existing glass as a retrofit measure, thus reducing the SHGC of an existing clear glass considerably while maintaining a high visible transmittance and lower U-factor. Other conventional tinted and reflective films will also reduce the SHGC but at the cost of lower visible transmittance. Reflective mirror-like metallic films can also decrease the U-factor, since the surface facing the room has a lower emittance than uncoated glass.

Adding an addition **roomside (also known as the 4th surface) (gtypes_2lowe4.php)** low-E coating to the low-E coating in an insulating glazing unit allows for increased thermal performance without having to add another layer of glass. Infrared heat is generated inside a room. Adding this roomside low-E coating reflects the heat back into the space which reduces the amount of radiant heat loss through the glass.