Sunlight Reflected from Double-Paned Low-E Windows, and Damage to Vinyl Siding and Other Materials

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Overview

Direct sunlight has the capability of heating the surface of materials through absorption well above the ambient air temperature. Even so, the heat from direct sunlight does not generally result in significant damage to building materials, beyond effects associated with fading and weathering. Reflected sunlight from modern windows is another matter. Glass in double paned windows may on occasion slightly warp or deflect due to a difference in the barometric pressure between the interior of the glass panes and the outside air pressure. This can create a concavity in the glass. Such a concavity is a normal response to pressure differences, does not affect the performance of the window, and does not constitute a defective window condition. However, the concavity may focus sunlight reflected from the window in a fashion similar to the effect seen when light passes through a magnifying glass. This focused light may land on adjacent building surfaces, and appear as a brilliant star-shaped spot. The concentrated heat generated by the focused reflected sunlight results in surface temperatures well above that encountered from direct sunlight, and has the capability of causing damage to exposed materials, especially those which are plastic based.

Vinyl Siding

According to the U.S. Census Bureau, vinyl siding has been the most commonly used exterior cladding on new single family homes every year since 1994. Homeowners appreciate its durability (under most conditions), and its low maintenance qualities - no painting. But, vinyl siding is a plastic based product, and as such is susceptible to the heat effects caused by focused reflected sunlight. The Vinyl Siding Institute (VSI) states that temperature ranges beginning at 160-165 degrees Fahrenheit can soften normal grades of vinyl siding. Darker colors absorb more heat, and will soften before lighter colors of siding. There have been reports of reflected sunlight heat damage to materials other than vinyl siding, such as wood

and paint discoloration, and damage to other plastic based products, such as automobile components, lawn furniture, decking, window lineals, and trim.

Low-e Windows - Reflected Sunlight Effect

The use of double-paned low-e windows are now generally mandated by modern building and energy codes for new home construction. Low-e window glass is coated with a thin layer of metal or metallic oxide. Visible light passes through low-e windows without difficulty, but the metallic layer blocks the passage of heat inducing ultraviolet light into the home, reflecting that light outward. This keeps the home cooler in summer. In winter the effect is reversed, with interior heat blocked from passing outward. In this way low-e windows reduce energy costs.

The use of double paned low-e windows will not necessarily result in any damaging reflected sunlight incident. A combination of contributing factors must be present before the effect occurs or causes damage to any nearby materials, including vinyl siding. The presence of the concavity in the double glass panes and the focusing of the reflected light beam appear to be the primary cause of damaging heat generation, more so than the mere increased reflectivity of the low-e window. According to Mark LaFrance, a spokesperson for the U.S. Department of Energy (DOE), clear glass will reflect 10% of the sunlight's energy, while low-e windows reflect 30-50%. So while any double-paned window may generate a focused beam of reflected sunlight, the greater reflectivity of low-e glass exacerbates the effects of the focused reflected beam by generating more heat. The heat from double paned low-e window reflected sunlight has been measured in excess of 200 degrees Fahrenheit at its point of focus, more than sufficient to soften and distort any normal grade or color of vinyl siding.

Other conditions may have an influence. The angle of the sun is a factor. A low angle of sunlight (such as might occur in late fall, winter, or early spring) is more likely project the reflected sunlight beam outward, away from the ground and onto the surface of nearby buildings. Proximity to a neighboring structure is a factor. An NAHB Builders' Survey conducted in 2011 indicated that most vinyl siding damage occurs when the distance between the window and the siding is 30 feet or less. However, distances of up to 100 feet between window and vinyl siding have been reported. Other factors such as wind speed, air temperature, and the presence of buffering foliage all appear to have an impact on whether the reflected sunlight results in damage.

Range and Extent of Observed Effect

Distortion to vinyl siding from reflected sunlight has been reported in all geographic regions where vinyl siding is used. First reported in the late 1990's, observed incidents have risen proportionally with the increase in the use of low-e windows in residential construction. Exact numbers of reflected sunlight damage incidents are unknown, but an informal poll of major builders disclosed approximately 2000 incidents over a 10 year period. The NAHB Builders' Survey received 152 reported incidents. Reflected sunlight damage to vinyl siding has been observed everywhere vinyl siding is used, primarily in more northern states, but also in Virginia, and North and South Carolina. There are fewer reports of reflected sunlight damage in areas such as Florida and Texas where vinyl siding is less frequently used, and much fewer reports from states west of the Mississippi River where there is a manufacturing requirement for the installation of capillary tubes in double paned window construction. There are also fewer incident reports from areas where fresh air ventilation is more common than air conditioning, apparently due to the diffusing presence of window screens.

Argon Low-e Windows

There are different types of low-e windows available in specific climate zones. Low-e windows with high solar heat gain coefficients and low conductivity are preferred for northern climates where passive solar heating is advantageous in winter months. In order to retain the passive solar heat in the home, a dense, low conductivity gas, commonly argon, fills the area between the sealed glass panes. However, argon low-e windows have a greater incidence of glass deflection, resulting in those sunlight focusing concavities. This seems to be because the argon atom is smaller than natural air molecules. Over time the argon gas will escape through the window seal, but since the air molecules are too big to enter and replace the argon, there will be a barometric pressure difference between the interior of the panes and the outside air that can cause glass deflection. So, the prevalent, often mandated use of argon low-e windows in northern states appears to be a factor in the greater incidence of reflected sunlight vinyl siding damage in these areas.

Remediation Efforts

Since the factors and conditions that produce the reflected sunlight damage effect can reoccur, just replacing damaged vinyl siding is not a permanent solution. Placing an exterior screen over the offending window has been shown to mitigate the damage effect by diffusing the reflected light and reducing its focus. Or, hanging an awning over the window will prevent the reflection from

reaching an adjoining home. But, these solutions generally require the cooperation of the neighbor who owns the reflecting window. At times these neighbors are cooperative, but some are not, and then other remedies must be explored. Blocking the reflected sunlight will eliminate the damage. This can be achieved by planting intervening trees and shrubs, or installing any barrier sufficient to block the reflected light. Some homeowners have experimented with installing an ivied trellis over the vinyl siding to intercept the reflected beam. Also, replacement of damaged vinyl siding with another non-plastic based exterior cladding that can withstand the reflected heat is a solution, but expense becomes a factor with this course of action, and mismatched cladding on the affected side can pose aesthetic objections as well. Replacing low-e windows with less-reflecting clear glass windows is a possible remedy, but depending on the jurisdiction, low-e coated windows could be mandated by the local building code (making the use of clear glass illegal).

CAPILLARY TUBES - Another suggestion for avoiding the reflected sunlight damage effect involves the use of double paned windows equipped with capillary tubes installed during the window manufacturing process. The capillary tube connects the interior space between the window panes to the outside air, permitting a gradual equalization of barometric pressure, and thereby lessening the possibility that a concavity will develop in the glass. Without the concavity in the glass, reflected sunlight is unfocused, its intensity is diminished, less heat is generated, so there is less likelihood that nearby vinyl siding will become distorted.

In the higher altitude Western States, capillary tubes in double paned windows are mandated by manufacturing protocols for homes located at greater than 5000 feet in altitude. The tubes are needed because the reduced outside air pressure found at altitude can result in distorted or cracked window glass. The regional presence of capillary tubes in low-e windows appears to be the reason why there are so few reports of reflected sunlight damage to vinyl siding in the Western States. As evidence, there was a reported incident of vinyl siding distortion damage in the Tacoma, Washington area (elevation below 5000 feet). The builder replaced the original double paned windows (not equipped with capillary tubes) with windows that were equipped with capillary tubes. After replacement, there was no reported reoccurrence of vinyl distortion from reflected sunlight.

Low-e windows supplied east of the Mississippi do not as a practice come equipped with capillary tubes, but builders can request tube equipped windows from the manufacturer. The additional cost of tube equipped windows is said to

be nominal, from $0 to $1.00 per window. Many production builders in the east have reported their decision to only use capillary tube installed low-e windows in future construction in hopes of avoiding incidents of vinyl siding damage from reflected sunlight in their developments.

Capillary tubes are not always the answer, however. These tubes cannot be used in argon filled low-e windows. The presence of a capillary tube would allow the argon gas to immediately escape, thereby making that beneficial feature useless. So, if the building code requires an argon gas filled low-e window, the use of a capillary tube is not an option.

Double Strength Glass

Double paned windows are normally manufactured with single strength glass 3/32" thick. Double strength glass 1/8" thick is also commonly produced by glass manufacturers, but not routinely used for windows. Double strength glass keeps a flatter surface, and is less subject to deflection. That would lessen the possibility that a concavity will occur in the glass panes, and lessen the chance that reflected sunlight will be focused and cause damage to nearby vinyl siding. Reportedly, there is very little cost difference involved in manufacturing windows with the thicker glass, but to date there has been little manufacturing of windows with double strength glass.

Heat Resistant Vinyl Siding

The Lubrizol Corporation and the Kaneka Texas Corporation each manufactures a CPVC product for use in vinyl siding. CPVC siding is said to withstand heat ranges of 185 to 220 degrees Fahrenheit (normal grade vinyl siding begins to distort at 160 – 165 degrees). The cost of CPVC siding is currently several times that of regular siding, making it non-cost effective compared to other exterior cladding materials. Also, the product is reportedly more difficult to extrude and to mold into siding.

The Vinyl Siding Institute reports that other chemical companies and vinyl siding manufacturers are actively exploring formulation of heat resistant vinyl siding products, but these are undeveloped and not in production.

Liability and Warranties

To date, there has been no reported litigation concerning damage caused to vinyl siding by sunlight reflected off low-e or other double paned windows. Some attorneys have made demands on behalf of vinyl damaged clients against the

owners of offending windows based on public nuisance grounds. At least one homeowner indicated an intent to file a complaint with the Consumer Product Safety Commission based on fire safety concerns. However, there have been no reported instances of fires, and the temperature readings for focused reflected sunlight (less than 250 degrees F.) are well below the combustion temperature of wood – 451 degrees Fahrenheit. The possibility that reflected sunlight poses a fire hazard has been investigated in several states, including Massachusetts and North Carolina, but ultimately discounted. In the future, as the phenomenon of damage to vinyl siding from low-e window reflection becomes more well-known, it may be expected that lawsuits could be filed against architects and builders based on theories of negligent design or construction for failing to anticipate the problem and for failure to make an effort to prevent or avoid this situation.

Home owners with distorted vinyl siding routinely make warranty claims against their builders, the siding supplier, and the manufacturer. For more than a dozen years, vinyl siding manufacturers have included this standard exclusion in their warranties… "This warranty does not apply to siding products… which have been distorted or melted due to an external heat source, including but not limited to a barbecue grill, fire, or reflection from windows, doors, or other objects." Despite the warranty exclusion, if pressed, vinyl siding manufacturers will sometimes offer to furnish replacement siding on a one-time basis, labor not included.

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