BRANZ

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APPLIED WINDOW FILMS

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- This bulletin discusses films used to modify the performance of glazing.
- It covers their features and benefits, application processes and appropriate use.
- This bulletin replaces Bulletin 421 *Windows – films and coatings*.

1.0 INTRODUCTION

1.0.1 Glazed windows and doors allow daylight and sunshine into a house and provide views and a connection to the outdoors. However, clear glazing can also allow in too much heat, glare or ultraviolet light, can let out too much heat and does not give occupants much privacy. Applying a film to glazing can modify these unwanted characteristics.

1.0.2 Sheet films are sometimes used as secondary glazing, where the film is separated from the existing glazing, typically to give inexpensive, temporary thermal insulation. This is covered in Bulletin 507 *Timber windows – retrofit glazing options for thermal improvement* and not in this bulletin, which covers only after-market films applied directly to the glass.

1.0.3 Films can be used within laminated glass at the factory. That application is not covered here.

1.0.4 This bulletin replaces Bulletin 421 *Windows – films and coatings*

2.0 BENEFITS OF APPLIED FILMS

2.0.1 Applied films can provide the following benefits:

- Reduced fading of furnishings by reducing the transmission of ultraviolet radiation, heat and light. Effectiveness can be measured as ultraviolet (UV) percentage reduction, the damage weighted fading transmission (DWFT) or another parameter.
- Reduced glare coming into a room. Effectiveness is measured as a reduction in visual light transmission (VLT).
- Reduced solar heat gain in a room that overheats because of sunlight streaming in. Effectiveness is measured as a reduction in solar heat gain coefficient (SHGC).
- Reduced heat loss. Energy management films are typically under 40 microns thick. Some with a low-emissivity (low-E) surface can increase heat retention by up to 40%, but performance is lost if there is condensation on the glazing. Some suppliers of window films offer computer simulations of energy cost savings that can be achieved with particular films.
- Reduced graffiti damage by reducing the adherence of paint and etching/tagging, being readily cleanable and providing a tougher applied surface layer (with similar characteristics to glass) that is less easily damaged. Anti-graffiti films also take the form of invisible sacrificial films that can be peeled off.
- Improved maintainability by reducing the ability of certain materials to stick or by enhancing a photocatalytic effect (where the coating chemically breaks down organic dirt).
- Improved safety by making the glazing more visible where glazing systems appear to offer unimpeded passage.
- Improved security by making forced entry through broken windows and doors more difficult because the film holds broken pieces together. However, this is difficult to measure, and specialist advice should be obtained. Some older glazing systems cannot be made secure through the application of films since the glazing can be removed from the outside. To enhance security of these, the complete window system needs replacing. Some security films also provide protection against damage and injury in severe storms and earthquakes and can also mitigate damage from bomb blasts. Security films can also have metal layers incorporated to protect computers against electrical, radar or radio interference. To achieve the required performance, these films range in thickness from 175 microns to over 350 microns.
- Provision of privacy in bathrooms, bedrooms or meeting rooms by making the glazing translucent or opaque or to simulate one-way glazing. One-way glazing provides a view in one direction only, typically from the darker side to the lighter side, but this can reverse if lighting conditions change.
- Decoration with patterns, colour tinting or reflective window treatment. Film can also be used for colour graphics of company logos and advertising.
- Improved safety from injury by holding shards of broken glass together to minimise the likelihood of harm to occupants. Some of these films can be used to meet the requirements of New Zealand Building Code clause F2 *Hazardous building materials*. Thickness of safety films range from 100 microns to 150 microns.
- Reduced noise. Applied films can provide a very small reduction in noise transmission. Replacing existing glazing with acoustic laminated glass is a better option. Where sound travels through gaps and cracks around glazing, film will not reduce noise. Where glazing is used for internal partitions or walls, sound is often reflected and can travel through internal spaces. Specialist advice should be sought in these cases.

Note: While the use of some films can have a marginal effect on the reduction of condensation (this effect can be measured as a surface temperature or as an R-value), there are better solutions, such as reglazing with IGUs in thermally broken frames where condensation is the primary issue.

2.0.2 Some films combine more than one function – for example, a safety film may also reduce glare and fading of fabrics, or a film may have a high solar heat gain coefficient (SHGC) but low visible light transmittance (VLT).

2.0.3 Films can also be supplied clear, tinted or reflective to varying degrees.

3.0 PERFORMANCE

3.0.1 Most manufacturers produce a range of films to suit specific requirements. They provide charts that compare the properties of their films with the properties of clear glass. These typically include:

- solar heat gain coefficient (SHGC)
- ultraviolet radiation transmitted (UV%)
- glare reduction
- visible light transmitted (VLT%)

- solar energy reflected and transmitted (%)
- U-value (W/m^{2}K)
- total solar energy transmission (ET).

3.0.2 Reported performance of films varies widely and should be independently verified. Examples are:

• SHGC	0.2–0.99 (20–99% shading)
• visible light transmission	6–63%
• ultraviolet reduction	up to 99%
• glare reduction	10–90%
• total solar energy transmission	0.2–0.9 (20–90%)
• U-value (W/m^{2}K)	3.3–5.85.

3.1 FADING

3.1.1 The UV spectrum is commonly separated into UVA, UVB and UVC. The atmosphere blocks the harmful UVC, ozone deals with most (but not all) UVB but UVA passes through.

3.1.2 The three main causes of fading of paint, fabrics and furnishings are ultraviolet radiation (especially UVA rays), heat and visible light. Humidity, artificial lighting and poor dye anchorage only have a small impact. Figure 1 indicates the typical size of these effects.

3.1.3 Clear glass stops most UVB rays but very little UVA. Window films can be used to reduce the UVA rays, as well as heat and light transmission. Polyester films absorb 99% of UV rays, including UVA. No film can completely eliminate fading.

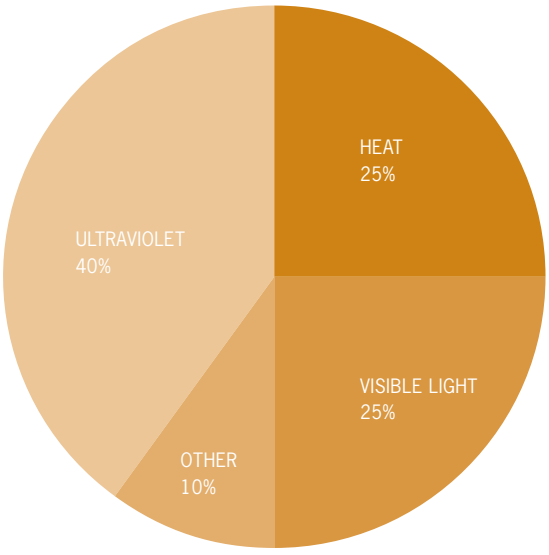

Figure 1. The causes of fading of furnishings and fabrics

4.0 SELECTING A WINDOW FILM

4.0.1 The first step is to determine the required window performance improvement required for example, reduced heat loss through glass, improved safety, enhancing privacy or reducing UV.

4.0.2 The second step is to decide the most effective way of achieving the required performance improvement. The options are applying films, reglazing or replacing entire window systems. Factors influencing the decision include:

- cost
- accessibility/convenience – film is typically applied from inside the building while reglazing or window replacement may require scaffolding
- the level of performance improvement that can be achieved – adding a film to reduce sound will not give the performance that can be achieved with acoustically designed glazing, and similarly, a film that reduces heat loss will not provide the same level of performance as the retrofitting of insulating glazing units (IGUs), and the thermal performance of an IGU is typically unaffected by condensation
- what will give the most effective result for example, adding film to glazing in the air-leaky timber sashes of an old uninsulated villa will have little impact on making the house warmer.

4.0.3 Once it has been decided that a film may be a viable option, consult specific film and glass manufacturers' information before specifying or ordering to ensure the following:

- The film will give the performance required and its performance is backed by independent reputable testing. For example, if it is to reduce solar heat gain by 50%, a film with an SHGC of 0.5 is required.
- The film can be applied safely to the existing glazing – restrictions may apply on the installation of a film to tinted glazing (especially if the glass thickness is 6 mm or more), reflective, laminated, patterned or wired glass. (Clear safety film is safe to apply to all types of glazing.)
- Film used to increase the safety of glass has its performance verified by testing in accordance with AS/NZS 2208:1996 *Safety glazing materials in buildings* and marked accordingly before it can be claimed to comply with the requirements of Building Code clause F2.
- The film does not have a negative impact on the life cycle of the glazing, window or building. Some glazing systems have environmental product declarations (EPDs) that provide an independent assessment of their environmental impact, and applying a film can change this. For example, some films:
  - cannot easily be removed and may prevent recycling of the glazing
  - take a lot of energy to manufacture and may increase the embodied energy of the glazing system – ask if the supplier/manufacturer has a life cycle assessment (LCA) or EPD for their products
  - may alter – positively or negatively – the amount of heating or cooling energy required in a room.
- The chosen film will not make the internal space too dark by reducing the daylight too much or by significantly altering the outside appearance of the glazing.

4.1 INAPPROPRIATE USE

4.1.1 Inappropriate use of some types of film may cause glass to break as a result of thermal stressing, caused by increased absorption of solar energy. This

risk will vary with the darkness of the tint and type of film used. Increased expansion of the glass may also result in breaking the putty seal in older windows with hard putty or glass breakage if clearances are inadequate.

4.1.2 Application of film to low-E glazing may negate the benefits of the existing low-E coating. Consult the glass manufacturer if known or a glass supplier to confirm whether the film can be applied.

4.1.3 Other issues and possible undesirable effects from films that need to be considered include:

- reflective films may cause glare in adjacent buildings
- some films can cause internal reflectance, reducing the ability of occupants to see out of the building under certain light conditions
- as the film ages or is exposed to weather, it can become unsightly
- the colour of low-quality dyed films changes over time
- films can be scratched during cleaning
- internal condensation can increase if the film has a low-E surface.

5.0 NEW ZEALAND BUILDING CODE REQUIREMENTS

5.0.1 Building Code clauses B2 *Durability*, F2 *Hazardous building materials* and G7 *Natural light* can apply to the use of window films. Films applied to glazing systems after market must not reduce the ability of the glazing to comply with the Code. However, they do not need to comply with the Code themselves, unless they are providing added performance such as converting glazing to safety glass.

5.1 DURABILITY

5.1.1 While the durability of after-market films does not need to meet the provisions of B2 for 5-year durability (unless they are providing added performance such as converting glazing to safety glass), it is expected that films should be durable for at least this period. Check the manufacturer's literature for durability statements.

5.2 HAZARDOUS BUILDING MATERIALS

5.2.1 The objective of clause F2 *Hazardous building materials* is to safeguard people from injury and illness caused by exposure to hazardous materials.

5.2.2 Glass is a potential hazard, and the performance requirement F2.3.3 makes specific reference to glass.

5.2.3 The Acceptable Solution F2/AS1 references NZS 4223.3:1999 *Glazing in buildings – Part 3: Human impact safety requirements*. In Appendix A of this standard, clause 3:A7 defines safety organic-coated glass: "A glazing material consisting of a piece of glass coated and permanently bonded on one or both sides with a continuous polymeric coating, sheet or film." These are normally products supplied complete from a factory with certification to AS/NZS 2208:1996 *Safety glazing materials in buildings*.

5.2.4 There are some instances where safety film can be applied to glazing to achieve compliance with AS/NZS 2208 for human impact. In these cases, the glazing (excluding roof glazing) will effectively be converted to safety glass, but this is only true for specific films and specific circumstances and needs independent verification.

5.3 LIGHT TRANSMISSION

5.3.1 NZBC clause G7 *Natural light* has a performance requirement that buildings be designed to ensure that luminance at floor level be a minimum of 30 lux, but this is seldom of practical significance, as this level is extremely low when compared with recommended levels in Table B1 of NZS 6703:1984 *Code of practice for interior lighting design*. Of more concern is the requirement in G7 for occupants to be aware of the outside, which is a major function of external glazing. Films should not be so dark that they prevent occupants from being aware of the outside.

6.0 MATERIALS AND INSTALLATION

6.1 SHEET FILMS

6.1.1 All window films, except vinyl decorative film, use polyester film as the base. This may be modified by dyes, metallic coatings or UV inhibitors. The final film is often made from laminating a number of layers of very thin material together. They can be manufactured to provide a hard, scratch-resistant surface that is not damaged by normal window cleaning.

6.1.2 An adhesive is usually applied to one surface to adhere the film to the glass. Adhesives may be dry (water-activated) or pressure-sensitive. Pressure-sensitive and some dry adhesives are covered with a release liner that is peeled off at the time of film application.

6.1.3 Water-activated adhesives have a longer cure time and lower initial peel strength than pressure-sensitive adhesives.

6.1.4 Metallic coatings may be deposited on the polyester film, in the factory, by:

- a vapour deposition method where metal is vaporised then condenses on the film surface, or
- a 'sputtering' method, where atoms are dislodged from a metal target and allowed to strike the film surface at high velocity to form a uniform metal layer. The sputtering method permits the use of multiple layers of metal to create non-fading colours. Nickel, stainless steel, copper, aluminium and silver are commonly used.

6.1.5 Film thickness ranges from 38–360 microns depending on the type of film and its possible uses. Film comes in roll widths 900–1800 mm (approximately).

6.1.6 All films, except anti-graffiti films and some special exterior solar-control films, should be applied to the interior surface of the glazing as the durability of external films can be low due to factors such as sun and abrasion.

7.0 FILM APPLICATION

7.0.1 Films should be applied by trained applicators using specialised equipment. Product suppliers tend to work with authorised applicators who have been trained in the correct techniques.

7.0.2 The first critical step is cleaning the glass surface.

7.0.3 Film is normally applied with a very small gap (1–2 mm) around the perimeter of the glass. This can appear as a bright band and be visually disturbing in some circumstances when looking at light and dark views.

7.0.4 The glass temperature at the time of application is not critical, but ideally material should not be applied to windows when it is hot, as this makes application more difficult. Pressure-sensitive adhesive will grip too fast, making it difficult to avoid blisters in the film.

All photos courtesy of the Window Film Association of Australia and New Zealand (WFAANZ).

7.0.5 At lower temperatures, the water used to activate some adhesives may take longer – between 48 hours and 7 days – to disappear from behind the film or condensation may prevent pressure-sensitive adhesives from sticking.

7.0.6 Films produce a slight odour during and shortly after application, but this gradually dissipates with normal ventilation.

8.0 CARE OF WINDOW FILMS

8.0.1 To extend the life of films:

- don't use abrasive cleaners or stiff bristle brushes for cleaning – use a soft cloth with standard liquid window cleaners, making sure there are no grit particles on the cloth
- avoid ammonia-based cleaners
- don't lift corners or edges
- give the adhesive time to cure after application and wait 30 days before the first cleaning
- don't tape anything to window film
- avoid paint spatters on films as they cannot be removed.

9.0 WARRANTY

9.0.1 Warranties vary from 3 years for dyed films to 'lifetime' – for as long as the original purchaser remains in the dwelling for good-quality films applied to domestic windows and typically 10–12 years in commercial buildings. Warranties usually cover peeling, cracking and adhesive and hard-coat failure. Some high-quality metallised films are warranted against discolouration. There does not appear to be a standard test for durability.

10.0 REFERENCES

***New Zealand Building Code* (NZBC)**
AS/NZS 2208:1996 *Safety glazing materials in buildings*
NZS 4223.3:1999 *Glazing in buildings – Part 3: Human impact safety requirements*
NZS 6703:1984 *Code of practice for interior lighting design*

11.0 FURTHER READING

IWFAA *Flat Glass Education Guide* www.iwfa.com

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