Research Summary

Restoring discoloured uncoated timber cladding

Peter Kaczmar

Introduction

There has been an increasing trend to use uncoated wood cladding as the exterior facade to new building projects, both domestic and commercial. Such facades can provide an attractive, long-lived and above all, natural alternative to man-made cladding options.

Uncoated cladding has been used primarily because of its low maintenance requirement, on account of the absence of a decorative finish. Many architects choose to specify uncoated cladding because they want the wood to weather to a silver-grey appearance in order to meet their design aims.

Uncoated cladding using species such as oak, sweet chestnut or western red cedar has traditionally been used in its uncoated condition to good aesthetic effect. However, occasionally problems with surface disfigurement can arise which can alter the appearance of the cladding and detract significantly from its aesthetic impact. Instances of disfigurement can be sporadic, and the likelihood of their occurrence is difficult to predict with any degree of certainty. Moreover, when disfigurement does occur, there is currently no recognized or established protocol which can be offered to the consumer as a preventative measure against its recurrence.

In recognition of these issues, which would compromise consumer perception of exterior timber cladding if left unaddressed, TRADA has funded a two-year programme of research, the aims of which were to:

- identify the cause(s) of the various forms of discoloration of unfinished exterior cladding in service
- establish the effectiveness of selected preventative treatment measures aimed at preventing in-service discoloration and disfigurement
- develop appropriate strategies for the remedy and long-term prevention of discoloration on exterior cladding.

Principal causes of discoloration

Previous TRADA Technology consultancy reports written for specific sites provided detailed information and allowed an analysis of the main causes of disfigurement on exterior uncoated cladding. The research team found 42 specific report references, of which 32 were considered to be detailed enough to enable an accurate judgement as to what the most likely cause of disfigurement was in each particular case. The search enabled sufficient information to be gathered to identify the principal causes of in-service discoloration.

Amalgamation of the data identified 11 separate causal factors of disfigurement (*Figure 1*), of which three were attributable to issues of wood growth and natural colour variation. Basic analysis of these data showed that the most common causes of discoloration were attributable to:

- black surface growth, collectively termed ‘mould’
- iron staining
- the redistribution of naturally occurring tannins (‘extractive staining’)
- differential bleaching resulting from differential exposure to weathering.

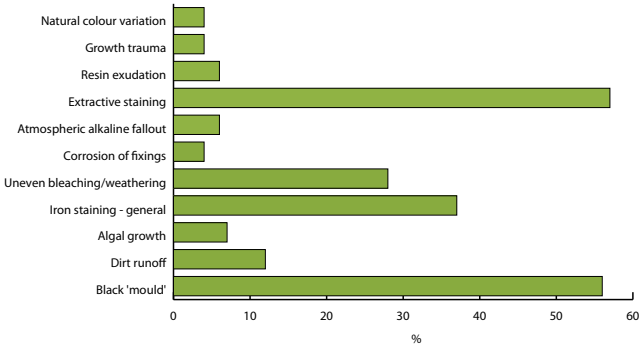

Figure 1 Principal causes of in-service discoloration on uncoated exterior timber cladding

Black discoloration

The discoloration referred to as ‘mould’ growth was found to be caused by a melanized or black form of yeast fungus from the genera *Aureobasidium* or *Hormonema*, which produces a characteristic black discoloration on new and weathered wood (*Figure 2*).

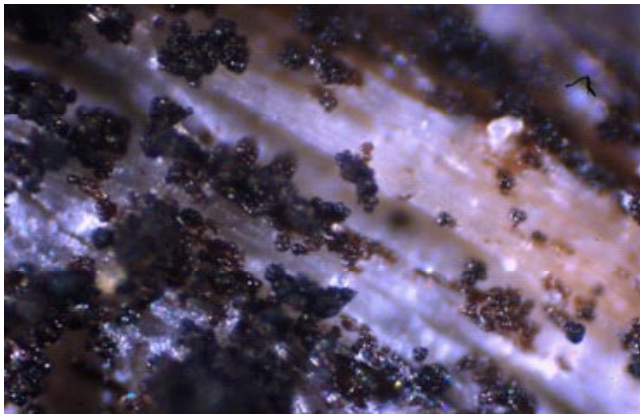

Figure 2 Melanized surface yeast growing on oak

The fungal organism uses naturally occurring sugars present in the wood, as well as the breakdown products of delignification, and requires moisture in order to sustain growth. This type of discoloration is most prevalent on unprotected aspects which are subjected to high levels of solar radiation. It is much less of a problem on areas which are sheltered from direct sunlight and rainfall, such as beneath eaves, overhangs and canopies *(Figure 3*).

Figure 3 Typical shadow lines on cladding caused by differential weathering

The manner in which cladding is fixed can also influence the development of this type of disfigurement. Discoloration by surface yeasts can cause the development of 'shadow lines', which often can be seen running down areas of cladding and which can mimic or shadow the presence of fixing battens, particularly if the inner wall of the building is not provided with an adequate vapour barrier. This can occur on close-jointed cladding, where warm air from the interior of the building can migrate into the back of the cladding, condense and prompt fungal disfigurement on the cladding surface (Figure 4).

Figure 4 Light vertical lines on close-jointed oak cladding

In cases where the cladding is open-jointed, rainwater penetrating past the rainscreen can be channelled down the fixing battens and held against the backs of the boards to create localized discoloration along lines of battens as vertical dark bands (*Figure 5*).

Figure 5 Dark vertical lines on open-jointed sweet chestnut cladding

Extractive staining

Wood contains a complex mixture of organic compounds which are water-soluble and able to migrate within the wood in response to cyclic changes in moisture and ambient conditions. The redistribution of these extractives in wood is known to produce uneven and unsightly staining, which is sometimes referred to as 'tannin staining' or 'water marking'.

It is especially important to consider the water-shedding dynamics of buildings at the design stage, particularly if unusual designs are proposed, since the manner in which water is shed down the building may be a factor in determining whether this form of staining is likely to develop. The research indicated that this form of staining occurs as a tenuous surface phenomenon which, in severe cases, can form a discrete zone of extractives at the surface *(Figures 6 and 7).*

Figure 6 Extractive staining on western red cedar beneath break in eaves canopy

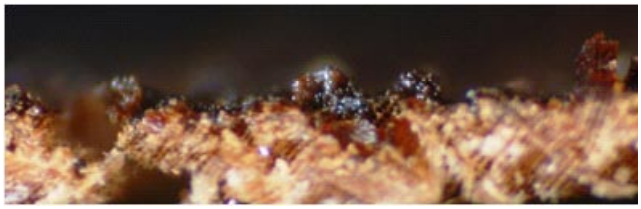

Figure 7 Transverse section taken from surface of western red cedar cladding with severe extractive staining, showing dark-coloured extractives confined to the surface zone

Cleaning trials

A series of experimental trials were implemented at three separate field locations designed to test a number of permutations of cleaning and remedial treatment regimes. The test sites represented cladding made from oak and sweet chestnut, which were heavily disfigured with black *Aureobasidium* growth, and western red cedar, where the main staining was due to tannin redistribution.

The trials experimented with various cleaning treatment formulations including:

- bleach
- sodium carbonate peroxyhydrate
- sodium hydroxide
- oxalic acid-based colour restorer

Given that the *Aureobasidium* existed as a surface growth, attempts were also made to remove the discoloration by pressure-washing with water. This proved to be an extremely effective, quick and easy method of removal of the surface growth and enabled large tracts of cladding to be cleaned with a single pass of the water jet (*Figure 8*).

Figure 8 Surface cleaning of discoloured sweet chestnut cladding using a domestic pressure washer

The process of pressure-washing also removed the friable zone of delignified surface fibres on the wood caused by the process of weathering, restoring the original colour of the wood. In addition, it was effective against disfigurement caused by tannin redistribution. This meant that the same process could be used to remove three of the four principal causes of discoloration identified by the literature review as being the most problematic to consumers, (i.e. bleaching/surface greying, tannin staining and mould discoloration).

Treatment options

After cleaning, the cladding was allowed to dry and then treated with a number of colourless treatments, including:

- commercial decking-protection treatment
- penetrative water-repellent treatment
- water-borne preservative solution

Some test areas were left in their cleaned condition with no treatment, in order to investigate whether any residual uptake of the cleaning products used (bleach, sodium hydroxide, etc) conferred any long-term protection against the re-colonization of the surface micro-organisms (*Figures 9 and 10*).

Figure 9 Test areas on sweet chestnut 14 months after cleaning, showing differential levels of re-colonization according to treatment

Figure 10 Test bays on oak cladding immediately following cleaning and treatment

Case study

Pressure-washing was found to be the most effective method of cleaning discoloured cladding. In one field case study, the opportunity arose to demonstrate the process to good effect on a three-storey building project. The facade was clad with horizontal close-jointed western red cedar boards, pressure-washed and then treated with a colourless, resin-based decking-protection product as an expedient to prevent the re-emergence of discoloration and extractive staining (compare *Figures 11 and 12*).

Figure 11 Discoloured western red cedar cladding before cleaning and treatment

Figure 12 Discoloured western red cedar cladding following cleaning and re-treatment

Pressure-washing

The research showed that the main type of disfigurement occurring on uncoated cladding was caused by a surface growth of melanized yeasts. The disfigurement was largely tenuous, occurring on the surface of weathered and new wood as loose cells (ie, not clinging to the surface in mycelial or strand form), making it easy to dislodge by a physical cleaning processes such as pressure-washing. The second most prevalent type of disfigurement, caused by the redistribution of natural extractives, was found to leave a discrete surface deposit on cedar cladding which could be removed by pressure-washing as well.

Pressure-washing was found to remove most forms of surface disfigurement easily and quickly and could be used effectively on large buildings. Using a short stand-off distance between the water lance and substrate could effectively remove the degraded surface zone of the weathered wood, restoring the cladding to its original, natural colour. Larger stand-off distances were necessary with softer species to ensure that the surface of the wood did not become scoured or marked by the pressure-washing process.

Re-colonization

Significant re-colonization by surface yeasts and subsequent disfigurement was found to recur within one year of cleaning by pressure-washing alone. Washing with caustic soda and hypochlorite-based bleaching products slowed the re-emergence of surface discoloration to some extent, but moderate levels of discoloration still re-emerged within one year.

While treatment with a brush-applied preservative prevented re-colonization by surface yeasts, substrate bleaching was found to be significant after one year. Treatment of the surface with a resin-based decking-protection product yielded the best results in terms of preventing the re-emergence of surface discoloration after approximately one year of weathering, and also minimized or prevented subsequent bleaching of the substrate over that time.

Recurrence of staining

Pressure-washing and treatment with a resin-based decking-protection product resulted in the prevention of disfigurement caused by the migration of natural extractives to the surface after eight months of subsequent weathering.

Little or no extra benefit was gained from using a proprietary caustic soda-based tannin remover (followed by neutralization with an oxalic acid product) on western red cedar and oak cladding.

Some evidence was found to suggest that if the cleaning and remedial treatment process was carried out on old and weathered cladding, discoloration was less likely to recur.

Future developments

This research has provided information relating to the main in-service causes of discoloration on uncoated exterior timber cladding. Based on empirical information derived from a number of case studies, the research team have identified a number of effective methods of remedying its occurrence. TRADA has extended the research project in order to gain further understanding of the effectiveness of the different remedial options based on longer periods of weathering.

Further reading

Davies, I. and Wood, J., External Timber Cladding: Design, Installation and Performance, Edinburgh Napier University, 2010

Hislop, P., External timber cladding, 2nd edition, ISBN 978 1900510554, TRADA Technology, 2007

Kaczmar, P., Investigation into the discoloration of external unfinished cladding, its prevention and remedial treatment, TRADA Technology report ref TC//T10126, 2010

Uznovic, A., Byrne, T., Gignac, M. and Yang, D.Q. Wood discolorations and their prevention—with an emphasis on bluestain, FPInnovations, Special Publication SP-50, 2008

About the author

Peter Kaczmar is Senior Technical Consultant at TRADA Technology, with expertise in wood coatings and treatments, flooring and exterior joinery. He has extensive on-site investigative, analytical and consultancy experience. He was Head of TRADA's chemical and analytical laboratories (Wood Technology) for over 15 years and has been their Coatings and Treatments Specialist for over 20 years.

TRADA Technology Ltd is contracted by the Timber Research and Development Association to prepare and publish all of its publications.

TRADA Technology Ltd
Chiltern House, Stocking Lane, Hughenden Valley
High Wycombe, Buckinghamshire, HP14 4ND UK
t: +44 (0)1494 569600, **f**: +44 (0)1494 565487
e: information@trada.co.uk, **w**: www.trada.co.uk