

Pretreatments for powder coating on architectural aluminium



This paper sets out the changes affecting the specification of powder coatings on architectural aluminium. This arises due to the following:

- Likely phasing out the use of chromate pretreatment on architectural aluminium,
- The withdrawal of BS 6496 and its replacement with BS EN 12206-1

This note summarises the current situation and provides interim information for specifiers. As the situation becomes clearer further guidance will be issued.

Pretreatment of Aluminium

Pretreatment of aluminium prior to application of a powder coating is required to ensure satisfactory adhesion between the metal and the powder coating and that this adhesion is not impaired by subsequent corrosion of the aluminium surface. Where failure of the powder coating occurs due to inadequate pretreatment, remedial recoating on site is unlikely to be effective.

The use of chromate as specified in BS 6496 and EN 12206-1 has been used for many years. It is tried and tested and there are established methods for testing the conversion coating produced by the process. While the process is technically satisfactory, there are concerns about the use of the hexavalent chromium products in the pretreatment process due to the health risks for those working in the industry and environmental risks if it is released into the environment. Environmental contamination may occur from rinse water as well as the base chemicals and disposal of contaminated waste has become increasingly difficult.

It had been confirmed that the use of hexavalent chromium would be prohibited after the sunset date of September 2017 under the REACH (Registration, evaluation, authorisation restriction of Chemicals) Regulations (<https://echa.europa.eu/authorisation-list/-/dislist/details/0b0236e1807e0228>). After this point products incorporating or produced using hexavalent chromium cannot be sold, bought or used without authorisation. Applications for authorisation (for the products to be used after the sunset date) are currently under review and include a consortium (CTAC) covering a number of downstream uses including surface finishing of aluminium. It is believed an extension of up to four years will be granted, however this is yet to be confirmed. Even if the material is not prohibited by law, some companies may avoid its use as it conflicts with their environmental policies.

There are some areas within Europe where it has not been permitted for many years (for example the state of Berlin banned its use in the early 1990's).

The use of chromate free pretreatments may be beneficial to the assessment of buildings under environmental sustainability schemes such as BREEAM and LEED.

Pretreatment processes

A number of different pretreatment processes are currently used;

- **Hexavalent chromium (also known as CrVI(Cr6)/chromium trioxide/chromate)**
This typically gives a yellow colour to the pretreated aluminium. Hexavalent chromium is present in both the pretreatment chemicals and the coating produced on the aluminium so CrVI pretreated aluminium would be prohibited by any ban on hexavalent chromium, regardless of the source/origin.
- **A combined phosphate/chromate**
BS EN 12206-1 and BS 6496 also allow a combined phosphate/chromate pretreatment which gives a green coating, often referred to as green chromate. Results from laboratory testing show that this has a slightly inferior corrosion protection compared to hexavalent chromium pretreatment, however it has been in use for many years, and its long-term performance is well documented. It has been the dominant form of pretreatment in the UK. There is no hexavalent chromium in the coating produced on the aluminium but the pretreatment chemicals contain hexavalent chromium and it is therefore subject to any ban on hexavalent chromium.
- **Trivalent chromium (CrIII)**
Recently developed as an alternative to hexavalent chromium. These are intended to be a direct replacement for the hexavalent chromium process and may offer advantages if converting an older pretreatment plant. Trivalent chromium is not a chromate, and therefore it is not directly covered by the ban on hexavalent chromium. However, hexavalent chromium may be used in the production of the pretreatment chemicals and hence they may be affected by the ban. Some treatments have been assessed and approved by Qualicoat and GSB.
- **Pre-anodising** (see below).
- **Chrome-free pretreatments** (see below).

Hexavalent chromium and the combined phosphate/chromate are classified as conventional pretreatments in accordance with BS EN 12206-1 and BS 6496. Prescriptive guidance can be followed which results in an acceptable level of performance.

Trivalent chromium, pre-anodising and chrome-free chemicals are classified as alternative pretreatments in accordance with BS EN 12206-1. They are permitted if their performance is demonstrated through laboratory testing and natural exposure in an aggressive environment. Natural exposure should be for 2 years for provisional approval and 5 years for full approval in both marine and industrial conditions, in accordance with BS EN ISO 8565.

Accelerated durability testing may not fully represent long term in service exposure and until products using these alternative pretreatments have been in service for their full design life in a given location/environment, there will remain some concern that they may not perform as well as chromate pretreatments.

The use of a company operating under a third party accreditation scheme, such as Qualicoat or GSB, ensures that the pretreatment process has been assessed and is monitored by a QA scheme.

Powder coating has to be applied within a short period of pretreatment and hence the two processes must be carried out as a coordinated operation.

Pre-anodising

Pre-anodising (also referred to as 'special', 'flash' or 'technical' anodising) is a requirement for some paint warranties in marine environments. There are a large number of different pre-anodising processes, with sulphuric acid pre-anodising being most commonly used for architectural aluminium. It is widely regarded as an excellent form of pretreatment, however it has been little used over the last 25 years. If pre-anodising is used as a pretreatment for powder coating, the anodic layer is generally 3 to 8 microns thick and must be left unsealed.

The following points should be taken into account when considering the use of pre-anodising:

- Pre-anodising may be more expensive than alternative chemical pretreatments,
- Pre-anodising requires appropriate rinsing to fully remove any residual sulfates from the surface,
- EN 12206-1 uses the term 'electrolytic conversion' to refer to pre-anodising. It does not give any details of the process other than requiring evidence of the performance of coatings applied with the pretreatment from both laboratory tests and natural exposure. To date, CWCT has not been provided with any natural exposure test evidence. However, it consistently performs better than chromate and alternatives in Qualicoat's Annual Global Report, albeit with a limited sample size. Whilst there has been a low incidence of failure in service, there has been limited use of sulphuric acid pre-anodising in the past,
- There is no European/British Standard giving requirements for pre-anodising. Both Qualicoat and GSB have requirements in their standards but they differ in some respects. Differences include rinsing and drying temperatures and the permitted time between pre-anodising and powder coating. Qualicoat are setting up a group to review their requirements,
- There is limited pre-anodising capacity available at present within the UK and European coating industry.

Chrome free chemical pretreatments

A number of alternative chrome free chemical conversion coating processes have been developed, some of which have been in use for a number of years. There is a growing consensus on the effectiveness of these alternative pretreatments, with data from Qualicoat indicating that they give equal performance to chromate pretreatment. However some remain concerned that there is a lack of relevant natural exposure data as required by EN 12206-1.

It is thought that at least half the industry has now changed to chrome free pretreatment. Those which have converted to chrome free pretreatment are likely to be newer plants which have closer control of the process.

The following points should be taken into account when considering the use of chrome free pretreatment:

- *A large number (about 100) different chemical processes.*
This makes it difficult for a non-expert to assess the suitability of a pretreatment process. The processes can be grouped into a number of 'families' but there is no

agreement on which are best. Third party QA schemes (Qualicoat and GSB) have been developed which include procedures for assessing the performance of these pretreatments and these allow specifiers to ensure that suitable pretreatments are selected.

- *Testing.*

All pretreatments covered by Qualicoat and GSB have satisfied all the mandatory laboratory tests required by EN 12206-1 and have also undergone the optional (in EN 12206-1) filiform and wet adhesion test. The latest data from Qualicoat (2015) indicates that the failure rate in laboratory salt spray testing at 1000 hours is now lower for chromate free pretreatments than chromate pretreatment although when extended over 1000 hours chromate pretreatments still perform better.

Systems approved by GSB have a minimum of 3 years exposure data from the Hook of Holland and some systems have 10 years of exposure data. Systems approved by Qualicoat have 2 year exposure data from Genoa.

- *Need for close control of the process (more so than for chromate pretreatment) and test methods to demonstrate that they have been carried out correctly.*

Pretreatment carried out by companies operating under the Qualicoat and GSB schemes are required to carry out regular monitoring under agreed protocols including independent third party testing, and random checking. The coatings produced are colourless but can be detected with suitable instruments, and test plates can be taken in order to test the pretreatment.

- *Suitability for UK climate.*

Chromate free pretreatments have been used widely in a number of European countries providing acceptable performance. It is sometimes argued that the UK climate may be more aggressive and hence these pretreatments may not give the same level of performance in the UK. Ten year exposure data from the Hook of Holland may go some way to meeting this concern, but further comparative assessment may be appropriate.

Standards for powder coating

BS 6496 was issued in 1984. It is out of date and is now considered to have a number of technical deficiencies. It was withdrawn in 2004 following the publication of BS EN 12206-1 but subsequently reinstated. Due to the new restrictions in the use of chromate pretreatments, BS 6496 is no longer applicable, and has been withdrawn again (Feb 2017).

BS EN 12206-1 overcomes some of the shortcomings of BS 6496. It allows both pre-anodising and chromate free pretreatments to be used in addition to the traditional chromate and chromate/phosphate pretreatments. It gives prescriptive requirements for chromate pretreatments in the form of coating thickness. For alternative pretreatments it sets performance requirements in terms of laboratory tests and natural exposure tests of the coated metal, as discussed above.

Qualicoat and GSB have their own standards/specifications for powder coating architectural aluminium. The requirements are largely based on those given in EN 12206-1, together with additional QA procedures for the powder coater.

Pretreatment systems which comply with BS EN 12206-1 fall short of the standards required by Qualicoat/GSB in the following ways;

- There is no requirement for assessment of filiform corrosion. This is required by Qualicoat and GSB.
- Pretreatment is assessed by performance testing of powder coated aluminium. The pretreatment includes an etch stage and the degree of etch is known to affect performance. EN 12206-1 does not have a prescriptive requirement for the etching degree whereas Qualicoat requires a minimum of 1g/m² and for seaside applications 2g/m² is required.
- EN 12206-1 requires an average film thickness of at least 50µm whereas Qualicoat requires 60µm for class 1 and 2 powders.

EN 12206-1 only applies to powder coating. It was intended that there would be an EN 12206-2 covering liquid applied coatings but this has not been produced. EN 12206-1 is due for review.

Conclusion

This note summarises the current changes affecting the specification of powder coatings on architectural aluminium and provides interim information for specifiers. As the situation becomes clearer further guidance will be issued.

Specifications should be based on EN 12206-1. BS 6496 is out of date and has been withdrawn.

Specifying a Qualicoat or GSB approved pretreatment product ensures that the pretreatment process will have been subject to an independent approval process. For both GSB and Qualicoat the laboratory assessment exceeds the requirements of EN 12206-1. Products assessed to GSB stage 4 also exceed the requirements of EN 12206-1 for natural weathering in an aggressive environment. Other products will have been assessed for natural weathering to a lower standard.

Chrome free chemical pretreatments are available that have test data that exceed the requirements of EN 12206-1 for both laboratory testing and natural exposure in an aggressive environment.

Accelerated tests for durability do not fully represent long term in service exposure and there remains a small risk that some alternative pretreatments may not provide the same level of long term performance in service as established chromate pretreatments. This can only be demonstrated when products in service reach the end of their service life.

Pretreatment of aluminium includes an etch stage. The normal etch requires the removal of 1g/m² of aluminium. For seaside applications 2g/m² is required by Qualicoat. The increased etch improves durability, and may be specified in all areas which will help to mitigate any risk associated with the use of chromate free pretreatments.

The risk of premature failure depends on the environment, and the consequences of failure depend on the nature of the product. There is little concern about the durability of alternative pretreatments for internally exposed components. For curtain walling the bulk of the coated aluminium is internal and external components are often replaceable. If the specifier is concerned that alternative pretreatments will not provide adequate durability, alternative finishes that do not require pretreatment, such as anodising, can be considered.

Specifications requiring chromate pretreatment will become increasingly difficult to meet as more processors change to chromate free pretreatment and will be undeliverable when the ban is fully implemented.

Pre-anodising can be used as an alternative pretreatment but at an increased cost. It is a pre-requisite for certain enhanced corrosion resistance classes under GSB, and is widely regarded as an excellent form of pretreatment, although there appears to be a lack of test evidence to support this, as required by EN 12206-1.

There are currently a limited number of powder coaters that can provide pre-anodising, which may restrict a competitive tendering process.