



Aluminum Pretreatment to Support Structural Adhesive Bonding

1 Scope

1.1 Material Description. This specification is intended to cover the requirements and process of a pretreatment system that can be used to condition aluminum substrates to achieve structural adhesive bonds, which will meet the strength and durability requirements for specified automotive applications.

1.2 Symbols. Not applicable.

1.3 Applicability. This pretreatment could be used to prepare all types of aluminum substrate that would then be utilized for structural bonding applications.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3059

3 Requirements

3.1 Cohesive Separation Mode. Aluminum substrates pretreated according to this specification, and bonded with approved structural adhesive systems, shall demonstrate cohesive separation within the adhesive layer when stressed to bond delamination. In order to achieve this type of adhesive separation mode consistently, it is anticipated that the substrate surface must be chemically standardized prior to the application of the conversion coat.

3.2 Standardized Surface Condition. To attain this **standardized** surface condition, it will be necessary to conduct a surface investigation to determine the level of **de-ox and etch** required on production representative **as received** substrate. Production representative **as received** substrate is critical since the degree of required **de-ox and etch** is dependent upon the actual thickness of aluminum oxide present on the substrate. Oxide thickness can vary dependent on several factors. The oxide layer on substrate used for production may vary only within a narrow bandwidth so that the identified, and specified, **de-ox and etch** process validated as satisfactory in the process development, remains legitimate for the purpose of structural bonding.

3.3 Conversion Coating. It is expected that the conversion coating process will contain the following steps, or stages.

3.3.1 Alkaline cleaning to remove organic contaminants.

3.3.2 Water rinse (City water).

3.3.3 Water rinse (Deionized/Reverse Osmosis (DI/RO)).

3.3.4 De-oxidizing/etch to remove resident oxide layer.

3.3.5 Water rinse (City water).

3.3.6 Water rinse (DI/RO).

3.3.7 Application of the conversion coating.

3.3.8 Water rinse (City water).

3.3.9 Water rinse (DI/RO).

3.3.10 Drying.

Note: The expectation is that this process will result in the formation of a conversion coating on the surface of the aluminum. Currently, there are several different types of commercially available aluminum pretreatments that may be suitable in providing an acceptable interface between the aluminum substrate and the structural adhesive.

As an example, for this specification, consider a popular conversion coating used in North America and other regions, which is based on a controlled layer of Titanium and Zirconium Oxides, along with a "polymeric" component.

For this system, the recommendation for coating weight on the finished coating, would be $6 \text{ mg/m}^2 \pm 2 \text{ mg/m}^2$ for aluminum sheet, and on aluminum extrusions, or aluminum castings, the recommended coating weight would be $10 \text{ mg/m}^2 \pm 5 \text{ mg/m}^2$.

Different types of conversion coatings will likely have different recommendations regarding coating weights.

It is the intention of this specification that whatever conversion coating is applied to an aluminum part and/or assembly from a prototype or production supplier, that specific conversion coating be identified, the coating weight, and the method of measurement for that coating weight be disclosed, and demonstrated. It is also expected that aluminum substrate, which is representative of the intended production part, treated with the production intent conversion coating, demonstrate, by means of laboratory stress durability testing, a bonding system (substrate, conversion coating, and adhesive) which is capable of providing satisfactory bond strength and durability.

Laboratory testing shall be performed on aluminum the substrate, (representative of the production part (s), both with, and without the conversion coating), to further demonstrate the efficacy of the intended coating.

4 Manufacturing Process

4.1 Pretreatment. The pretreatment process shall be designed and specified, so that the aluminum substrate treated will be dipped, or sprayed, in an appropriate alkaline solution. The intent is to remove dirt, dust, oil, etc., from the substrate. As mentioned in Section 3, this process includes removal of the resident **oxide** layer on the aluminum substrate. This is to obtain an optimal performance of the intended structural adhesive system so that separation of the adherents under stress will result in cohesive separation of the adhesive layer, the required separation mode.

4.1.1 Following this cleaning and rinse, the substrate is then de-oxidized and etched, prior to the deposition of a controlled conversion coating. This conversion coating is intended to serve as suitable bonding surface for approved and specified structural adhesive systems.

4.1.2 When the pretreatment process has been identified, and validated, by means of target coating weight determination, and structural bond testing; the process shall not change until revalidation of a new pretreatment process, coating weight, and/or aluminum substrate is completed.

5 Rules and Regulations

5.1 Legal Regulations. All materials must satisfy applicable laws, rules, regulations and recommendations valid in the country of usage.

5.2 Language. In the event of conflict between the English and domestic language, the English language shall take precedence.

5.3 Inspection and Rejection. Samples of components or materials released to a GM material specification shall be tested for conformity with the requirements of this material specification and approved by the responsible Engineering department prior to commencement of delivery of bulk supplies.

A new approval must be received for any changes, e.g., properties, manufacturing process, location of manufacture, etc. If not otherwise agreed, all testing and documentation normally required for initial release must be completed.

It is the responsibility of the supplier to inform the customer in a timely manner, without solicitation, and to include documentation of all modifications of materials and/or processes and to apply for a new release.