AMERICAN ARCHITECTURAL

AAMA 611-98

Voluntary Specification for Anodized Architectural Aluminum

MANUFACTURERS ASSOCIATION

TABLE OF CONTENTS

1.0 Scope 1

2.0 Purpose 1

3.0 Applicable Documents 1

4.0 Definitions 1

5.0 General 2

6.0 Inspection Of Metal Prior To Finishing 2

7.0 Schedule Of Finishes (AA D45) 2

8.0 Architect Approved Sample 3

9.0 Tests 4

AAMA. The Source of Performance Standards, Product Certification and Educational Programs for the Fenestration Industry.

This voluntary specification was developed by representative members of AAMA as advisory information and published as a public service. AAMA disclaims all liability for the use, application or adaptation of materials published herein.

American Architectural Manufacturers Association
1827 Walden Office Square, Suite 550, Schaumburg, IL 60173
PHONE 847/303-5664 FAX 847/303-5774
EMAIL webmaster@aamanet.org WEBSITE www.aamanet.org

All AAMA documents may be ordered at our web site in the "Publications Store".

Publish Date: 1998 Reissue Date: 1/2004

1.0 SCOPE

1.1 This specification describes test procedures and requirements for architectural quality aluminum oxide coatings applied to aluminum extrusions and panels for architectural products.

1.2 This specification covers anodized finishes produced in batch or continuous coil.

2.0 PURPOSE

This guideline will permit the architect, owner and contractor to specify and obtain anodized aluminum finishes which will provide, with periodic maintenance, a superior level of performance in terms of film integrity, exterior weatherability, and general appearance for many years.

3.0 APPLICABLE DOCUMENTS

3.1 The following standards form a part of this specification to the extent specified herein. The standards identified herein are those current at the time of publication of this specification. The user should contact AAMA to determine if later versions have been adopted.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 609-93, Voluntary Guide Specification for Cleaning and Maintenance of Architectural Anodized Aluminum

AAMA 800-92, Voluntary Specifications and Test Methods for Sealants

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117-95, Test Method of Salt Spray (Fog) Testing

ASTM B 137-95, Method for Measurement of Weight of Coating on Anodically Coated Aluminum

ASTM B 244-79 (1993), Standard Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments

ASTM B 487-90, Method for Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section

ASTM B 680-95, Standard Test Method for Seal Quality of Anodic Coatings on Aluminum by Acid Dissolution

ASTM D 523-94, Test Method for Specular Gloss

GENERAL SERVICES ADMINISTRATION (GSA)

GSA-FS-TT-S-00227E Nov. 1969, Sealing Compound, Elastomeric Type, Multi-Component (for Caulking, Sealing, and Glazing in Buildings and Other Structures)

INTERNATIONAL STANDARDS ORGANIZATION (ISO)

ISO 3210-1983, Anodizing of Aluminum and its Alloys - Assessment of Quality of Sealed Anodic Oxide Coatings by Measurement of the Loss of Mass After Immersion in Phosphoric-Chromic Acid Solution

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC Test Method 173-1991, **CMC**: Calculation of Small Color Differences for Acceptability

3.2 The following Aluminum Association standard is not a requirement. It is referenced for information only.

THE ALUMINUM ASSOCIATION (AA)

AA DAF 45-1980 (1993), Designation System for Aluminum Finishes

4.0 DEFINITIONS

4.1 Class I (A4)
High performance anodic finishes used in exterior applications receiving periodic maintenance such as curtain walls. Minimum coating thickness of 18 microns (0.7 mil).

4.2 Class II (A3)
Commercial anodic coatings used in interior applications or exterior applications receiving regularly scheduled cleaning and maintenance such as storefronts. Minimum coating thickness of 10 microns (0.4 mil).

4.3 Architectural Clear Anodic Coatings (A41 and A31)
Conventional aluminum oxide coatings which are formed in sulfuric acid based electrolytes. These coatings are transparent and allow the natural aluminum color to show through.

4.4 Integral Color Anodic Finishes (A42 and A32)
Coatings are formed in special electrolytes that produce colors in the aluminum oxide coating as it forms. A range of colors from light to dark bronze and black is achieved with this process.

4.5 Architectural Color Anodic Finishes (A43)
Clear aluminum oxide coatings that are dyed to produce a range of colors including gold, red, yellow, blue, turquoise

and black. Only colors meeting the weathering requirements as outlined in Section 9.7, Weathering, are covered by this specification. Anodizing process recommendations of the dye manufacturer are to be strictly followed. Additional coating thickness in excess of Class I may be necessary for exterior color-fastness. Electrodeposited coatings may also be overdyed (A44/A43).

4.6 Electrodeposited Color Anodic Finishes (A44)
Colored anodic coatings achieved in a multi-step process involving a clear anodizing step, followed by an electrolytic deposition of stable metal compounds at the pore base of the anodic coatings to obtain the color. A wide range of colors including the champagnes, bronzes, black, blue, burgundy, green, gray and gold can be achieved through different electrochemical techniques. A44 finishes may be overdyed to produce additional colors (A44/43).

4.7 Acronyms

AA	-	The Aluminum Association
AATCC	-	American Association of Textile Chemists and Colorists
ASTM	-	American Society for Testing and Materials
CMC	-	Color Measurement Committee of the Society of Dyers and Colorists
ISO	-	International Organization for Standardization

5.0 GENERAL

5.1 To meet this specification, products tested shall meet all the requirements of this specification.

5.2 The anodic coatings shall be continuous, uniform in appearance and free from powdery areas.

5.3 The aluminum shall be of a suitable alloy and have suitable surface quality for application of the anodic coating.

5.4 The aluminum alloy and temper to be used shall be agreed upon by the purchaser and the manufacturer.

5.5 Specifications for architectural anodic finishes must be comprehensive and written to ensure the following:

5.5.1 The finish meets the architect's specifications.

5.5.2 These requirements are clearly stated so bidders will quote on the same procedure.

5.5.3 Test procedures listed in Section 9 should be included so that inspections may be performed to assure that the architect's specifications have been met.

6.0 INSPECTION OF METAL PRIOR TO FINISHING

6.1 The fabricator/finisher shall be responsible for the workmanship and quality of materials used in the manufacture of the architectural components.

6.2 Examples of considerations that bear upon the quality of the finished aluminum are handling marks, scratches, in-plant corrosion, flatness, dimensional accuracy, welding techniques, die lines, oxide streaks and hot spots.

7.0 SCHEDULE OF FINISHES (AA D45)

7.1 The Aluminum Association's finishing designation, AA, as specified in AA DAF 45, "Designation System for Aluminum Finishes," should be employed to identify the anodizing system to be used for all components. This system may be supplemented by proprietary nomenclature systems, in which case the color and trade name would be included.

7.2 The Aluminum Association finish designation for pre-treatments both mechanical and chemical, as well as the anodic coating designation must be specified in sequence by the appropriate symbols following the prefix "AA". The designation system is used by all markets where anodizing is employed as a finish. Not
all its indicated options are appropriate or available to all markets, however, a complete listing can be found in AA DAF 45, "Designation System for Aluminum Finishes."

The nomenclature listed in the following table are the most commonly used for architectural products.

Type of Finish	Designation	Description	Examples of Methods of Finishes
Mechanical Finish	M12	Non-specular as Fabricated	
Chemical Finish	C22	Etched Medium Matte	Sodium hydroxide, 30-45 g/l (4-6 oz per gal) used at 49-66°C (120-150°F) for 5 to 10 min.
Anodized Finish Class I	A41	Clear	15% H_2SO_4 used at 21°C ± 1°C (70°F ± 2°F) at 129 A/m^2 (12 A/ft^2) for 60 min, or equivalent.
Anodized Finish Class I	A42	Integral	Color dependent on alloy and anodic process.
Anodized Finish Class I	A43	Dyed Color	15% H_2SO_4 used at 21°C ± 1°C (70°F ± 2°F) at 129 A/m^2 (12 A/ft^2) for 60 min followed by dyeing with organic or inorganic colors, or equivalent.
Anodized Finish Class I	A44	Electrodeposited Color	Application of the anodic coating followed by electrolytic deposition of inorganic pigment in the coating.
Anodized Finish Class II	A31	Clear	15% H_2SO_4 used at 21°C ± 1°C (70°F ± 2°F) at 129 A/m^2 (12 A/ft^2) for 30 min, or equivalent.
Anodized Finish Class II	A32	Integral Color	Color dependent on alloy and anodic process.
Anodized Finish Class II	A34	Electrodeposited Color	Application of the anodic coating followed by electrolytic deposition of inorganic pigment in the coating.

The following example shows how the designation system is used:

AA-M12C22A41

AA Aluminum Association
M12 Nonspecular as Fabricated
C22 Etched Medium Matte
A41 Anodized Finish - Class I - Clear

***NOTE 1**: Integral color anodic finishes are obtained with certain controlled alloys by (1) conventional sulfuric acid anodizing or (2) proprietary mixed acid (organic) anodizing.*

***NOTE 2**: Assemblies to be anodized must have drainage holes provided to prevent solution entrapment. (Consultation with the fabricator is recommended).*

***NOTE 3**: Welded joints must be carefully placed in an inconspicuous location if appearance after anodizing is important. When exposed welding is required, the fabricator or alloy supplier should be consulted as to the welding alloy to be used.*

***NOTE 4**: Assemblies to be anodized should not include non-aluminum metallic material.*

***NOTE 5**: Assemblies to be anodized should not include non-metallic material which would be degraded by process solutions or which would degrade the process solutions.*

7.3 The shop drawings approved by the architect should clearly identify the finish specified and the surfaces that will be exposed to view when the finished component is installed. When different finishes are specified on various wall components, they should be listed in an appropriate schedule which identifies the component, its alloy, temper and finish designation.

8.0 ARCHITECT APPROVED SAMPLE

8.1 If requested, the fabricator/finisher shall submit to the architect, for approval, representative samples of the allowable color range of each finish to be used on both sheet and extrusions. The samples should be large enough to demonstrate completed building appearance characteristics. Size and number of approval samples shall be mutually agreed upon.

8.2 A set of color range samples shall consist of two samples which represent the extremes of appearance to be expected on the finished components. The number of finally approved sets of color range samples to be submitted by the fabricator/finisher shall be mutually agreed upon with the architect.

8.3 Color Uniformity
The range samples shall not differ by more than 5 DE (CMC) when calculated in accordance with AATCC Test Method 173. Instrumental color measurements shall be taken with an instrument with CIE sphere geometry under conditions of a CIE illuminant D65 and the CIE 10° standard observer.

8.3.1 Color uniformity may vary in excess of the ranges permitted when various suppliers, coils, alloys, etc. are used. It is suggested that material lots not be mixed on jobs whenever possible.

8.4 Gloss Uniformity
The range samples shall not vary in gloss by more than 15 units when measured in accordance with ASTM D 523 using a 60° gloss meter.

9.0 TESTS

9.1 Oxide Coating Thickness

9.1.1 Major exposed surfaces as indicated on the shop drawings shall have a minimum oxide coating thickness of 18 microns (0.7 mil) for Architectural Class I and 10 microns (0.4 mil) for Architectural Class II when tested in accordance with ASTM B 244 or ASTM B 487.

A minimum of three readings shall be taken on a given area and averaged to allow for normal variations in instrument accuracy and in surface geometry.

***NOTE**: Recessed areas such as inside corners and channels are not to be used in measurements, but should be visually coated to the extent possible.*

9.2 Oxide Coating Weight and Apparent Density

9.2.1 Procedure
Sample coupons representative of actual production shall be tested in accordance with ASTM B 137.

9.2.2 Performance
The minimum oxide coating weight on sample coupons representative of production shall be:

Class I: 4.18 mg/cm^2 (27.0 mg/in^2)
Class II: 2.40 mg/cm^2 (15.5 mg/in^2)

9.2.3 The minimum apparent density of the oxide coating shall be:

All Classes: 2.32 g/cm^3 (38 g/in^3)

The apparent density of the anodic coating is obtained using the following equations:

$$d = \frac{10w}{t} \quad \text{or} \quad D = \frac{W}{T}$$

Where:
d = Apparent density of the anodic coating expressed in grams per cubic centimeter
D = Apparent density of the anodic coating expressed in grams per cubic inch
w = Weight of the sealed anodic coating expressed in milligrams per square centimeter
W = Weight of the sealed anodic coating expressed in milligrams per square inch
t = Thickness of the sealed anodic coating expressed in micrometers
T = Thickness of the sealed anodic coating expressed in mils measured according to ASTM B 244 or ASTM B 487

9.3 Color Uniformity

9.3.1 Procedure
Check random samples visually under a uniform light source or instrumentally under the same conditions as Section 8.3, Color Uniformity.

9.3.2 Performance
Color uniformity shall be within the established color range.

9.4 Gloss Uniformity

9.4.1 Procedure
Measure in accordance with ASTM D 523 using a 60° gloss meter.

9.4.2 Performance
Gloss uniformity shall be within established gloss range.

9.5 Abrasion Resistance (Michael Clark Abrasion Test)

9.5.1 Materials Required

9.5.1.1 A pencil eraser approximately 6 mm (1/4 in) thick and 12 mm (1/2 in) long.

9.5.1.2 Two grades of abrasive paper to the following specification:

ABRASIVE TYPE	GRADE	MOH'S NUMBER
Glass	"Flour"	4.5-5.5
Garnet	220 Grit	6.5-8.0

9.5.1.3 Cleaning Agent: Pumice powder, water and soft paper tissue.

9.5.2 Technique
Before performing the abrasive test the surface of the sample to be tested should be lightly cleaned with a water wetted paper tissue dipped in pumice powder. The surface is then cleaned and dried with a clean dry tissue. Care should be taken not to touch the cleaned area with fingers or any other greasy media before testing.

The abrasive paper is cut into strips approximately 12 mm (1/2 in) wide. Each grade of paper is wrapped in turn around the pencil eraser. The 6 mm (1/4 in) edge of the wrapped eraser is rubbed across the film to be tested for 10 double strokes in the cleaned area. The pressure should be similar to that used to erase pencil marks and the amplitude of the movement 10 mm - 20 mm (3/8 in - 3/4 in).

9.5.3 Performance
If the anodic film is harder than the chosen abrasive, the paper slips easily, and the film is merely burnished. A film dyed with organic dyes may color the paper, but no chalk-like dust will be picked up on the paper if the film is harder than the abrasive. If the abrasive is harder than the anodic film, a definite resistance is felt as the abrasive bites into the film. The anodic film is degraded and a significant quantity of white or colored chalk-like dust is picked up by the abrasive strip.

Anodic Finish Type	Abrasive Paper Test Film Not Degraded By
Sulfuric (AA 31, 33, 34) (AA 41, 43, 44)	Glass Paper
Integral Color (AA 32, 42)	Glass Paper, Garnet Paper

9.6 Corrosion Resistance

9.6.1 Procedure
Expose the sample according to ASTM B 117 using a 5% salt solution. Class I coatings are to be exposed for 3000 hours and Class II coatings for 1000 hours. Remove and wipe sample dry.

9.6.2 Performance
Test samples shall show no more than a total of 15 isolated spots or pits, none larger than 1 mm (0.031 in) in diameter, in a total of 381 cm^2 (150 in^2) of test area grouped from 5 or more test pieces.

9.7 Weathering

9.7.1 Procedure
Florida exposure South of latitude 27° North at a 45° angle facing South for 5 years.

9.7.2 Performance
Maximum of 5 DE(cmc) color change as calculated in accordance with AATCC Test Method 173 using conditions as in Section 8.3, Color Uniformity, of this specification. Color shall be measured on the exposed surface which has been cleaned according to AAMA 609 and corresponding values shall be measured on the original retained panel or unexposed flap area of the panel.

9.8 Seal Test

9.8.1 Procedure
Sample coupons processed with production loads, or actual production components should be tested in accordance with either ASTM B 680 or ISO 3210.

9.8.2 Performance
Maximum weight loss shall be 40 mg/dm^2 (2.6 mg/in^2).

9.9 Craze Resistance

9.9.1 Procedure
Place the anodized aluminum to be tested in an oven which has been preheated to 49°C (120°F), and is capable of maintaining a temperature which does not vary more than ±3°C (±5°F).

After 30 minutes, open the oven door and visually check the sample for crazing. If no crazing is present, close oven door and increase temperature by 6°C (10°F). After oven reaches temperature begin timing for 30 minutes and then recheck the sample for crazing. If no crazing is present, continue to increase the temperature by 6°C (10°F) and recheck in 30 minute intervals until crazing is present.

NOTE: *Evidence of crazing will be most visible on clear or light color samples.*

9.9.2 Performance
Anodized coating shall not craze below a metal temperature of 82°C (180°F).

10.0 SAMPLE AND TESTING

The fabricator/finisher shall be responsible for providing adequate sampling and testing to insure that the production quality meets the minimum test requirements. This responsibility includes maintaining records of all inspections.

10.1 Tests should be performed on coupons processed with production loads, or production parts to confirm conformance to this specification.

10.2 Test records should be kept on file and include the product date and respective test results.

11.0 SEALANT COMPATIBILITY

11.1 Sealant shall be compatible with anodic coatings and meet the performance requirements of AAMA 800 sealant specification. No deleterious affects such as organic coating separation, staining, lifting, discoloration or loss of adhesion shall be evident.

NOTE: *The fabricator of the finished products should consult his sealant supplier in selection of sealant which will exhibit adequate adhesion to the anodized surface. Panel exhibits of the specific coating to be used should be submitted to the sealant manufacturer for tests and recommendations. Peel adhesion tests as described in AAMA 800 or Federal Specification TT-S-00227E are suggested.*

12.0 REFERENCE SOURCES

The Aluminum Association (AA)
900-19th Street, N.W.
Washington, DC 20006
Phone: 202-862-5100
Fax: 202-862-5164

American Architectural Manufacturers Association (AAMA)
1827 Walden Office Square, Suite 550
Schaumburg, IL 60173
Phone: 847-303-5664
Fax: 847-303-5774

American Society for Testing and Materials (ASTM)
100 Barr Harbor Drive
West Conshohocken, PA 19428
Phone: 610-832-9500
Fax: 610-832-9555

American Association of Textile Chemists and Colorists (AATCC)
P.O. Box 12215, Research Triangle Park, NC 27709
Phone: 919-549-8141
Fax: 919-549-8933

International Organization for Standardization (ISO)
1 Rue De Varembe
Geneva, Switzerland CH-1211
Phone: 4122-749-011-11

Society of Dyers and Colourists (Color) (SDC)
P.O. Box 244, Perkin House
82 Grattan Road
Bradford, West Yorkshire 8D1 2JB England
Phone: 274-725-138

American Architectural Manufacturers Association
1827 Walden Office Square, Suite 550
Schaumburg, IL 60173
PHONE (847) 303-5664 FAX (847) 303-5774
WEBSITE www.aamanet.org
EMAIL webmaster@aamanet.org