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Standard Specification for Aluminum Oxide Powder [1]

This standard is issued under the fixed designation F 7; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers aluminum oxide (alumina) powder in two classes of particle size, two chemical grades, and two levels of acidity, for use as an insulating coating or as an ingredient of ceramic mixtures for components of electronic devices as follows:

1.1.1 *Particle Sizes:*

1.1.1.1 *Class A*—Particle size No. 500 nominal mesh (nominal average particle size = 24.3 µm).

1.1.1.2 *Class B*—Particle size No. 900 nominal mesh (nominal average particle size = 1.7 µm).

1.1.2 *Chemical Grades*—Grades 1 and 2 as specified under chemical requirements in Section 3.

1.1.3 *Acidity Levels*: pH (acid) 4.5 to 6.5 and pH (neutral) 6.5 to 7.5.

1.2 The following safety hazards caveat pertains only to the test methods in this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 183 Practice for Sampling and the Amount of Testing of Hydraulic Cement [2]

E 70 Test Method for pH of Aqueous Solutions with the Glass Electrode [3]

3. Chemical Composition

3.1 For a specified particle size and level of acidity, the aluminum oxide shall conform to the requirements of Table 1 as to chemical composition.

TABLE 1 Chemical Requirements

Element or Compound	Composition, %	
	Grade 1	Grade 2
Alumina (Al_2O_3), min	99.65	99.65
Silica (SiO_2), max	0.03	0.12
Magnesia (MgO), max	0.02	0.01
Ferric oxide (Fe_2O_3), max	0.04	0.04
Total alkali (as Na_2O), max	0.04	0.04
Carbon (C), max	0.01	0.01
Calcium oxide (CaO), max	0.02	0.01
Zirconium oxide (ZrO_2), max	0.01	0.01
Boron (B), max	0.001	0.002
Gallium oxide (Ga_2O_3), max		0.3
No other single metallic impurity to exceed	0.02	0.02
	Composition, ppm	
Water-soluble matter (as NaCl), max	300	300

4. Physical Properties

4.1 The alumina shall be "chalk white," dry, free from lumps, and of particle size distribution as agreed upon between purchaser and seller.

5. Sampling

5.1 Each lot of alumina shall be properly sampled in accordance with standard techniques, such as Practice C 183.

6. Test Methods

6.1 *Water-Soluble Content:*

6.1.1 *Procedure*—Determine the total water-soluble content by measuring the electrical conductivity of a 100-mL distilled or deionized water extract from a 5-g sample of alumina. Elutriate by vigorously shaking the alumina suspension in a flask for 1 to 2 min, allowing the solids to settle and decanting the clear supernatant liquid after 60 min. Measure the conductivity of the liquid with a standard cell and bridge. Correct this measurement for the "blank" reading on a similarly treated equal volume of the same pure water. Convert the net increase in conductivity of the water extract first to parts of water-soluble content as sodium chloride (NaCl) per million parts of water (factor is 1 micromho = 0.5 ppm NaCl), then relate to the actual weight of elutriated alumina. For example, on a typical 100-mL extract 10 micromhos (net) or 5 parts of NaCl per

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[2] *Annual Book of ASTM Standards*, Vol 04.01.

[3] *Annual Book of ASTM Standards*, Vol 15.05.

TABLE 2 Requirements for Sample Sizes and Dispersing Agents

Method	Sample Size, g	Sample Concentration Weight%	Dispersing Medium	Dispersing Agent
Coulter counter [A]	0.25	0.1	methanol	LiCl-38g/gal
M.S.A. centrifuge	1.0	0.03	H_2O	Na_2SiO_3 to pH = 10.5
Cahn Sedimentometer	0.4	0.03	H_2O	0.1 % $Na_2P_4O_7$
Sharples Micromerograph	0.06		N_2	none

[A]The instrument manufacturer recommends the following: sample size—0.0025 g, sample concentration—0.001 weight % , dispersing medium—0.9 % NaCl in H_2O, and dispersing agent—0.1 % $Na_2P_4O_7$.

million of water in this volume of liquid is equivalent to 100 parts of NaCl per million of alumina on the basis of a 5-g sample.

6.1.2 *Calculation*— Determine the parts per million of water-soluble content as follows:

$$\text{ppm} = 10^7 K_c[(R_b - R_x)/R_b R_x] \quad (1)$$

where:

K_c = cell constant, cm^{-1},
R_b = specific resistance of test water, Ω·cm, and
R_x = specific resistance of alumina extract in test water, Ω·cm.

6.2 *Particle Size*:

6.2.1 Determine particle size distribution by any of the following methods: (*a*) Coulter counter, (*b*) M.S.A. centrifuge method, (*c*) Cahn Sedimentometer, or (*d*) Sharples Micromerograph.

NOTE 1—Procedures for determining particle size by the methods shown in Table 2 are described in the operating manuals of the equipment listed.

6.2.2 Number average particle size may be taken as the 50 % point on the particle size distribution curve or may be measured by the Fisher sub-sieve sizer.

6.2.3 A density of 3.97 g/cm^3 for aluminum oxide will be used in all calculations.

6.2.4 Particle size distribution of acceptable material in both Class A and Class B will be by agreement between purchaser and seller. Sample size and method of dispersion will be identical in all test correlations, as specified in Table 2. Typical results are shown in Table 3.

TABLE 3 50 % Point Results of Particle Size Distribution Analysis on Typical Material—Diameter in Micrometers [A, B]

Method	Material (Class—Grade)†			
	A-1	A-2	B-1	B-2
Sharples Micromerograph	13.2	6.2	5.1	4.8
Cahn Sedimentometer	15.5	7.0	4.7	4.7
M.S.A. centrifuge	14.0	7.1	4.2	4.2
Coulter counter	17.1	8.1	6.6	5.2

[A]From Subcommittee I round-robin test results—Nov. 8, 1967.
[B]Variations between laboratories should not exceed 3 % on similar instruments.
† Editorally corrected.

6.2.5 Number average particle size of acceptable material in both Class A and Class B will be by agreement between purchaser and seller.

6.2.6 Complete dispersion of samples is essential and recommended procedure in Table 2 shall be followed.

6.3 *Hydrogen-Ion Concentration* (pH)*:*

6.3.1 Weigh out 20 g of the sample and transfer to a clean 100-mL beaker. Add 20 mL of distilled or deionized water and make into a slurry using a clean stirring rod. Stir for 1 to 2 min. Wash electrodes thoroughly with distilled or deionized water, remix slurry, immerse electrodes into slurry approximately 6 to 12 mm, and measure pH in accordance with Test Method E 70.

6.3.2 Any weight of slurry in the above ratio may be used provided there is sufficient slurry to immerse electrodes to the proper depth.

6.3.3 Wash electrodes immediately after using with several hundred millilitres of distilled or deionized water, removing the adhered slurry with the aid of a pipe cleaner. It is important for accuracy to prevent buildup of the slurry on the electrodes.

7. Keywords

7.1 alumina; particle sizing methods; powder