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Standard Specification for Sintered Ferrite Permanent Magnets[1]

This standard is issued under the fixed designation A1054; 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 technically important, commercially available, magnetically hard sintered ferrite permanent magnets.

1.2 Ferrite permanent magnets have residual induction B_r from 0.2 T (2000 G) up to about 0.5 T (5000 G) and intrinsic coercive field strength H_{cJ} from 160 kA/m (2000 Oe) up to about 400 kA/m (5000 Oe). Their specific magnetic hysteresis behavior (demagnetization curve) can be characterized using Test Method A977/A977M.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to customary (cgs-emu and inch-pound) units which are provided for information only and are not considered standard.

1.4 *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:*[2]

A340 Terminology of Symbols and Definitions Relating to Magnetic Testing

A977/A977M Test Method for Magnetic Properties of High-Coercivity Permanent Magnet Materials Using Hysteresigraphs

2.2 *Other Standards:*

MMPA Standard No. 0100-00 Standard Specifications for Permanent Magnet Materials[3]

IEC 60404-8-1 Magnetic Materials Part 8: Specifications for individual materials Section 1 – Standard specifications for magnetically hard materials[4]

3. Terminology

3.1 The terms and symbols used in this specification are defined in Terminology A340.

3.2 Terms that are not defined in Terminology A340 but are in common usage and used herein are as follows.

3.2.1 Recoil permeability, μ_{REC}, is the permeability corresponding to the slope of the recoil line. For reference, see incremental, relative, and reversible permeabilities as defined in Terminology A340. In practical use, this is the slope of the normal hysteresis loop in the second quadrant and in proximity to the B-axis. The value of recoil permeability is dimensionless. Note that in producers' product literature, recoil permeability is sometimes represented by the symbol μ_r, which is defined by Terminology A340 as relative permeability.

3.2.2 Magnetic characteristics change with temperature. Two key metrics of permanent magnet performance are residual induction, B_r, and intrinsic coercive field strength, H_{cJ}. The change in these characteristics over a defined and limited temperature range can be reversible, that is, non-destructive. This change is represented by values called reversible temperature coefficients. The symbol for reversible temperature coefficient of induction is $\alpha(B_r)$ and of (intrinsic) coercivity is $\alpha(H_{cJ})$. They are expressed in percent change per degree Celsius, %/°C, or the numerically equivalent percent per Kelvin, %/K. The change in magnetic characteristics is nonlinear so it is necessary to specify the temperature range over which the coefficient applies.

3.2.3 The maximum recommended working temperature of a permanent magnet, T_w, is a semi-arbitrary value sometimes assigned by magnet manufacturers to their products. T_w is not normative. See Appendix X3 for a more complete discussion.

4. Classification

4.1 The classification of ferrite permanent magnets is given in Tables 1 and 2, with cross-reference to MMPA Standard No. 0100-00 and IEC 60404-8-1 standards.

[1] This specification is under the jurisdiction of ASTM Committee A06 on Magnetic Properties and is the direct responsibility of Subcommittee A06.02 on Material Specifications.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from The International Magnetics Association (IMA), 8 South Michigan Avenue, Suite 1000, Chicago, IL 60603.

[4] Available from IEC (International Electrotechnical Commission) Central Office 3, rue de Varembé, P.O. Box 131, CH - 1211, GENEVA 20 Switzerland.

TABLE 1 Classification and Minimum Magnetic Property Requirements for Isotropic Sintered Ferrite Permanent Magnets

Material					Magnetic Properties				
ASTM Designation[A]	MMPA Brief Designation	Original MMPA Class	IEC Brief Designation	IEC Code Reference	Maximum Energy Product, $(BH)_{max}$ kJ/m^3 (MGOe)	Remanent Induction B_r mT (gauss)	Normal Coercive Field Strength, H_{cB} kA/m (oersted)	Intrinsic Coercive Field Strength, H_{cJ} kA/m (oersted)	Relative Recoil Permeability, μ_{REC}
CE-I-01	1.03/3	Ceramic 1	...	S1-0-1	8.4 (1.05)	230 (2300)	148 (1860)	259 (3250)	1.2

[A] Designations are XX-Y-ZZZ where:

XX = material type (CE = ceramic ferrite),
Y = processing and orientation (I = isotropic (non-oriented), A = anisotropic (oriented)), and
ZZZ = numeric grade designation.

TABLE 2 Classification and Minimum Magnetic Property Requirements for Anisotropic Sintered Ferrite Permanent Magnets

Material					Magnetic Properties				
ASTM Designation[A]	MMPA Brief Designation	Original MMPA Class	IEC Brief Designation	IEC Code Reference	Maximum Energy Product, $(BH)_{max}$ kJ/m^3 (MGOe)	Remanent Induction B_r, mT (gauss)	Normal Coercive Field Strength, H_{cB} kA/m (oersted)	Intrinsic Coercive Field Strength, H_{cJ} kA/m (oersted)	Relative Recoil Permeability μ_{REC}
CE-A-02	...	Ceramic 2	...	...	14.3 (1.8)	290 (2900)	191 (2400)	239 (3000)	1.1
CE-A-05	3.4/2.5	Ceramic 5	Hard ferrite 26/18	S1-1-6	27.1 (3.40)	380 (3800)	191 (2400)	199 (2500)	1.1
CE-A-06	...	Ceramic 6	...	...	19.5 (2.45)	320 (3200)	225 (2820)	263 (3300)	1.1
CE-A-07	2.7/4.0	Ceramic 7	Hard ferrite 20/28	S1-1-2	21.9 (2.75)	340 (3400)	259 (3250)	318 (4000)	1.1
CE-A-08A	3.5/3.1	Ceramic 8A	Hard ferrite 25/12	S1-1-5	27.9 (3.50)	385 (3850)	235 (2950)	243 (3050)	1.1
CE-A-08B	...	Ceramic 8B	...	...	32.8 (4.12)	420 (4200)	232 (2913)	236 (2960)	1.1
CE-A-10	...	Ceramic 10	...	...	30.4 (3.82)	400 (4000)	280 (3510)	288 (3617)	1.1
CE-A-11	...	Ceramic 11	...	...	34.4 (4.32)	430 (4300)	200 (2512)	204 (2560)	1.1
CE-A-21	3.4/3.9	...	...	...	27.1 (3.40)	380 (3800)	271 (3400)	310 (3900)	1.1
CE-A-22	4.0/2.9	...	...	...	31.8 (4.00)	410 (4100)	223 (2800)	231 (2900)	1.1
CE-A-23	3.2/4.8	...	...	...	25.5 (3.20)	370 (3700)	279 (3500)	382 (4800)	1.1
CE-A-24	3.8/4.0	...	...	...	30.3 (3.80)	400 (4000)	290 (3560)	318 (4000)	1.1

[A] Designations are XX-Y-ZZZ where:

XX = material type (CE = ceramic ferrite),
Y = processing and orientation (I = isotropic (non-oriented), A = anisotropic (oriented)), and
ZZZ = numeric grade designation.

5. Ordering Information

5.1 Orders for parts conforming to this specification shall include the following information:

5.1.1 Reference to this standard and year of issue/revision.

5.1.2 Reference to an applicable part drawing.

5.1.3 Magnetic property requirements if they are more stringent than the minimum values listed in the tables.

5.1.4 Quantity required.

5.1.5 The required magnetization state of the provided material (unmagnetized, fully magnetized, magnetized and thermally stabilized, magnetized and partially demagnetized or "calibrated"). This information should appear on the part drawing whenever possible.

5.1.6 Certification of magnetic property evaluation.

5.1.7 Marking and packaging requirements.

5.1.8 Exceptions to this specification or special requirements such as plating, coating, or functional testing as mutually agreed upon by the producer and user.

6. Chemical Composition

6.1 The general chemical composition of ferrite magnets is $MO \cdot 6Fe_2O_3$ with M being barium, strontium (strontium preferred due to environmental issues), or some combination of the two. New ferrite grades may also include some rare earth elements and cobalt. Chemical compositions listed in the tables are typical and are not guaranteed.

7. Physical and Mechanical Properties

7.1 Typical thermal properties are listed in Appendix X1.

7.2 Typical physical properties are listed in Appendix X2.