Designation: A 883/A 883M – 01

Standard Test Method for Ferrimagnetic Resonance Linewidth and Gyromagnetic Ratio of Nonmetallic Magnetic Materials[1]

This standard is issued under the fixed designation A 883/A 883M; 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 test method covers the measurement of the ferrimagnetic resonance linewidth and gyromagnetic ratio of isotropic microwave ferrites. This test is restricted to spherical specimens possessing resonance linewidths greater than 10 Oe [796 A/m].

1.2 The values and equations stated in customary (cgs-emu and inch-pound) or SI units are to be regarded separately as standard. Within this standard, SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with this standard.

1.3 *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. Summary of Test Methods

2.1 Ferrite materials, in general, exhibit at microwave frequencies a power loss or absorption which is a function of an applied DC magnetic field. In many ferrites, this dependence is of a simple form, having a single maximum at some value of the magnetic field, which depends on the microwave frequency and on the specimen shape. For ferrite materials showing this behavior, it is useful to characterize the absorption by means of an effective gyromagnetic ratio and a resonance linewidth. Note that ferrite materials exist for which the absorption has a more complex behavior as a function of DC magnetic field; this method is not intended to apply to such materials.

2.2 The value of the field for maximum absorption or resonance may be computed in terms of the magnetization of the sample, its geometry, the *effective gyromagnetic ratio*, γ, and the test frequency. For the case of a small spherical specimen, the dependence on specimen magnetization drops out and the effective gyromagnetic ratio can be computed from the relationship:

$$\omega = \gamma H_r \tag{1}$$

where:
ω = $2\pi f$;
f = microwave frequency, MHz; and
H_r = resonance magnetic field strength, Oe [A/m].

2.3 The second quantity characteristic of the absorption is the *ferrimagnetic resonance linewidth*, ΔH, which for the method described shall be defined as the separation of the two magnetic field values at which the power absorbed by the ferrite material is one half the maximum absorption. The performance obtainable in specific devices such as isolators, rotators, and so forth, is related to the linewidth and gyromagnetic ratio.

2.4 This test method of measuring the ferrimagnetic resonance linewidth and the gyromagnetic ratio of a ferrite material uses a cavity perturbation technique, which requires that the specimen be small compared to one quarter of the wavelength of the microwave radiation in the sample. Estimation of this wavelength requires knowledge of the relative dielectric constant, k, and permeability, k_m, of the specimen material under the conditions of measurement. The relative permeability depends on both the frequency and the magnetic field, but can be taken as −2 for the resonance condition in a sphere. The wavelength in centimetres, λ, in the specimen is then approximated by the equation:

$$\lambda = 3 \times 10^4/\sqrt{k} \tag{2}$$

2.5 The absorption in the specimen is measured by determining the changes of power incident on the cavity required to keep the output power from the cavity at a fixed reference level. It is necessary that the microwave frequency be adjusted to cavity resonance for all measurements. The variations in input power may be characterized by the variations of the attenuation inserted between a monitored source and the cavity to maintain the reference output level. If α_0 is this attenuator reading in decibels with no sample present, and α_r is this reading for maximum specimen absorption, then the reading

[1] This test method is under the jurisdiction of ASTM Committee A06 on Magnetic Properties and is the direct responsibility of Subcommittee A06.01 on Test Methods.

Current edition approved Oct. 10, 2001. Published December 2001. Originally published as C 524 – 63 T. ASTM Test Method F 130 – 86 was redesignated as A 883 – 86ε [1] in 1989. Last previous edition A 883 – 96.