

Standard Test Method for Sonic Velocity in Manufactured Carbon and Graphite Materials for Use in Obtaining an Approximate Value of Young's Modulus¹

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1. Scope*

1.1 This test method covers a procedure for measuring the sonic velocity in manufactured carbon and graphite which can be used to obtain an approximate value of Young's modulus.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in 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. Referenced Documents

2.1 *ASTM Standards:*²

C559 Test Method for Bulk Density by Physical Measurements of Manufactured Carbon and Graphite Articles

C747 Test Method for Moduli of Elasticity and Fundamental Frequencies of Carbon and Graphite Materials by Sonic Resonance

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI) (the Modern Metric System)

3. Terminology

3.1 *Definitions:*

3.1.1 *elastic modulus, n* —the ratio of stress to strain, in the stress range where Hooke's law is valid.

3.1.2 *Young's modulus or modulus of elasticity (E), n* —the elastic modulus in tension or compression.

3.2 *Definitions of Terms Specific to This Standard:*

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.F0 on Manufactured Carbon and Graphite Products.

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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.

3.2.1 *end correction time (T_e)*—the non-zero time of flight (correction factor), measured in seconds, that may arise by extrapolation of the pulse travel time, corrected for zero time, back to zero sample length.

3.2.2 *longitudinal sonic pulse*—a sonic pulse in which the displacements are in the direction of propagation of the pulse.

3.2.3 *pulse travel time, (T_t)*—the total time, measured in seconds, required for the sonic pulse to traverse the specimen being tested, and for the associated electronic signals to traverse the transducer coupling medium and electronic circuits of the pulse-propagation system.

3.2.4 *zero time, (T_0)*—the travel time (correction factor), measured in seconds, associated with the transducer coupling medium and electronic circuits in the pulse-propagation system.

4. Summary of Test Method

4.1 The velocity of longitudinal sound waves passing through the test specimen is determined by measuring the distance through the specimen and dividing by the time lapse, between the transmitted pulse and the received pulse.^{3,4} Provided the wavelength of the transmitted pulse is a sufficiently small fraction of the sample lateral dimensions, a value of Young's modulus for isotropic graphite can then be obtained using Eq 1 and Eq 2:

$$E = C_v \rho V^2 \quad (1)$$

where:

E = Young's modulus of elasticity, Pa,

ρ = density, kg/m³,

V = longitudinal signal velocity, m/s, and

C_v = Poisson's factor.

The Poisson's factor, C_v , is related to Poisson's ratio, ν , by the equation:

$$C_v = \frac{(1 + \nu)(1 - 2\nu)}{1 - \nu} \quad (2)$$

³ Schreiber, Anderson, and Soga, *Elastic Constants and Their Measurement*, McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020, 1973.

⁴ *American Institute of Physics Handbook*, 3rd ed., McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020, 1972, pp. 3–98ff.

*A Summary of Changes section appears at the end of this standard