



Standard Test Method for Measuring Ultrasonic Velocity in Advanced Ceramics with Broadband Pulse-Echo Cross-Correlation Method¹

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1. Scope

1.1 This test method describes a procedure for measurement of ultrasonic velocity in structural engineering solids such as monolithic ceramics, toughened ceramics, and ceramic matrix composites.

1.2 This test method is based on the broadband pulse-echo contact ultrasonic method. The procedure involves a computer-implemented, frequency-domain method for precise measurement of time delays between pairs of echoes returned by the back surface of a test sample or part.

1.3 This test method describes a procedure for using a digital cross-correlation algorithm for velocity measurement. The cross-correlation function yields a time delay between any two echo waveforms (1).²

2. Referenced Documents

2.1 ASTM Standards:³

- B311 Test Method for Density of Powder Metallurgy (PM) Materials Containing Less Than Two Percent Porosity
- C373 Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products, Ceramic Tiles, and Glass Tiles
- E494 Practice for Measuring Ultrasonic Velocity in Materials
- E1316 Terminology for Nondestructive Examinations

2.2 ASNT Document:

- Recommended Practice SNT-TC-1A for Nondestructive Testing Personnel Qualification and Certification⁴

¹ This test method is under the jurisdiction of ASTM Committee C28 on Advanced Ceramics and is the direct responsibility of Subcommittee C28.03 on Physical Properties and Non-Destructive Evaluation.

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² The boldface numbers in parentheses refer to the list of references at the end of this test method.

³ 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.

⁴ Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

2.3 Military Standard:

- MIL-STD-410 Nondestructive Testing Personnel Qualification and Certification⁵

2.4 Additional references are cited in the text and at end of this document.

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *back surface*—the surface of a test sample which is opposite to the front surface and from which back surface echoes are returned at normal incidence directly to the transducer.

3.1.2 *bandwidth*—the frequency range of an ultrasonic probe, defined by convention as the difference between the lower and upper frequencies at which the signal amplitude is 6 dB down from the frequency at which maximum signal amplitude occurs.

3.1.3 *broadband transducer*—an ultrasonic transducer capable of sending and receiving undistorted signals over a broad bandwidth, consisting of a thin damped piezocrystal in a buffered probe (search unit).

3.1.4 *buffered probe*—an ultrasonic search unit as defined in Terminology E1316 but containing a delay line, or buffer rod, to which the piezocrystal is affixed within the search unit housing and which separates the piezocrystal from the test sample (Fig. 1).

3.1.5 *buffer rod*—an integral part of a buffered probe, usually a quartz or fused silica cylinder that provides a time delay between the excitation pulse from the piezocrystal and echoes returning from a sample coupled to the free end of the buffer rod.

3.1.6 *cross-correlation function*—the cross-correlation function, implemented by a digital algorithm, yields a time delay between any two (ultrasonic) echo waveforms. This time is used to determine velocity (1).

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.