



Standard Guide for Resonant Ultrasound Spectroscopy for Defect Detection in Both Metallic and Non-metallic Parts¹

This standard is issued under the fixed designation E2001; 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 guide describes a procedure for detecting defects in metallic and non-metallic parts using the resonant ultrasound spectroscopy method. The procedure is intended for use with instruments capable of exciting and recording whole body resonant states within parts which exhibit acoustical or ultrasonic ringing. It is used to distinguish acceptable parts from those containing defects, such as cracks, voids, chips, density defects, tempering changes, and dimensional variations that are closely correlated with the parts' mechanical system dynamic response.

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

E1316 Terminology for Nondestructive Examinations

E1876 Test Method for Dynamic Young's Modulus, Shear Modulus, and Poisson's Ratio by Impulse Excitation of Vibration

E2534 Practice for Process Compensated Resonance Testing Via Swept Sine Input for Metallic and Non-Metallic Parts

3. Terminology

3.1 *Definitions*—The definitions of terms relating to conventional ultrasonics can be found in Terminology **E1316**.

¹ This guide is under the jurisdiction of ASTM Committee **E07** on Nondestructive Testing and is the direct responsibility of Subcommittee **E07.06** on Ultrasonic Method.

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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 Definitions of Terms Specific to This Standard:

3.2.1 *resonant ultrasonic spectroscopy (RUS), n*—a nondestructive examination method, which employs resonant ultrasound methodology for the detection and assessment of variations and mechanical properties of a test object. In this procedure, whereby a rigid part is caused to resonate, the resonances are compared to a previously defined resonance pattern. Based on this comparison the part is judged to be either acceptable or unacceptable.

3.2.2 *swept sine method, n*—the use of an excitation source to create a transient vibration in a test object over a range of frequencies. Specifically, the input frequency is swept over a range of frequencies and the output is characterized by a resonant amplitude response spectrum.

3.2.3 *impulse excitation method, n*—striking an object with a mechanical impact, or electromagnetic field (laser and/or EMAT) causing multiple resonances to be simultaneously stimulated.

3.2.4 *resonant inspection (RI), n*—any induced resonant nondestructive examination method employing an excitation force to create mechanical resonances for the purpose of identifying a test object's conformity to an established acceptable pattern.

4. Summary of the Technology (1)³

4.1 Introduction:

4.1.1 In addition to its basic research applications in physics, materials science, and geophysics, Resonant Ultrasound Spectroscopy (RUS) has been used successfully as an applied nondestructive testing tool. Resonant ultrasound spectroscopy in commercial, nondestructive testing has a few recognizable names including, RUS Nondestructive Testing, Acoustic Resonance Spectroscopy (ARS), and Resonant Inspection. Early references to this body of science often are termed the "swept sine method." It was not until 1990 (2) that the name Resonant Ultrasound Spectroscopy appeared, but the two techniques are synonymous. Additionally, impulse methods, like the striking of a rail car wheel with a hammer,

³ The boldface numbers in parentheses refer to the list of references at the end of this guide.

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