



Standard Practice for Quantitative Measurement and Reporting of Hypoeutectoid Carbon and Low-Alloy Steel Phase Transformations¹

This standard is issued under the fixed designation A 1033; 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 practice covers the determination of hypoeutectoid steel phase transformation behavior by using high-speed dilatometry techniques for measuring linear dimensional change as a function of time and temperature, and reporting the results as linear strain in either a numerical or graphical format.

1.2 The practice is applicable to high-speed dilatometry equipment capable of programmable thermal profiles and with digital data storage and output capability.

1.3 This practice is applicable to the determination of steel phase transformation behavior under both isothermal and continuous cooling conditions.

1.4 This practice includes requirements for obtaining metallographic information to be used as a supplement to the dilatometry measurements.

1.5 *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

E 3 Practice for Preparation of Metallographic Specimens

E 112 Test Methods for Determining Average Grain Size

E 407 Practice for Microetching Metals and Alloys

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *diametrical linear engineering strain*—the strain, either thermal or resulting from phase transformation, that is determined from a change in diameter as a result of a change in temperature, or over a period of time, and which is expressed as follows:

$$e_D = \Delta d/d_0 = (d_1 - d_0)/d_0$$

3.1.2 *hypoeutectoid steel*—a term used to describe a group of carbon steels with a carbon content less than the eutectoid composition (0.8 % by weight).

3.1.3 *longitudinal linear engineering strain*—the strain, either thermal or resulting from phase transformation, that is determined from a change in length as a result of a change in temperature, or over a period of time, and which is expressed as follows:

$$e_L = \Delta l/L_0 = (l_1 - l_0)/l_0$$

3.1.4 *steel phase transformation*—during heating, the crystallographic transformation from ferrite, pearlite, bainite, martensite or combinations of these constituents to austenite. During cooling, the crystallographic transformation from austenite to ferrite, pearlite, bainite, or martensite or a combination thereof.

3.1.5 *volumetric engineering strain*—the strain, either thermal or resulting from phase transformation, that is determined from a change in volume as a result of a change in temperature, or over a period of time, and which is expressed as follows:

$$e_V = \Delta v/v_0 = (v_1 - v_0)/v_0$$

$$e_V \approx 3e_L \approx 3e_D$$

3.2 *Symbols:*

e_L = longitudinal linear engineering strain

e_D = diametrical linear engineering strain

e_V = volumetric engineering strain

Δl = change in test specimen length

l_1 = test specimen length at specific temperature or time, or both

l_0 = initial test specimen length

Δd = change in test specimen diameter

d_1 = test specimen diameter at specific temperature or time, or both

d_0 = initial test specimen diameter

Δv = change in test specimen volume

v_1 = test specimen volume at a specific temperature or time, or both

v_0 = initial test specimen volume

A_{c1} = the temperature at which austenite begins to form on heating

¹ This practice is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.13 on Mechanical and Chemical Testing and Processing Methods of Steel Products and Processes.

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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.