



Standard Test Methods for Kinetic Parameters by Factor Jump/Modulated Thermogravimetry¹

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1. Scope

1.1 These test methods describe the model-free determination of Arrhenius activation energy by thermogravimetry using the factor jump (**1**)² (Method A) or modulated thermogravimetry (**2**) (Method B) techniques. With the assumption of a first-order kinetic model, the pre-exponential factor is additionally determined.

1.2 These test methods are applicable to materials with well-defined decomposition profiles, namely, a smooth, continuous mass change.

1.3 These test methods are applicable to decomposition occurring in the range from 400 K to 1200 K (nominally 100°C to 900°C). The temperature range may be extended depending on the instrumentation and material used.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 There is no ISO standard similar to this standard.

1.6 *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:³

- E473 Terminology Relating to Thermal Analysis and Rheology
- E1142 Terminology Relating to Thermophysical Properties
- E1582 Practice for Calibration of Temperature Scale for Thermogravimetry

¹ These test methods are under the jurisdiction of ASTM Committee E37 on Thermal Measurements and is the direct responsibility of Subcommittee E37.01 on Calorimetry and Mass Loss.

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

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.

- E1641 Test Method for Decomposition Kinetics by Thermogravimetry Using the Ozawa/Flynn/Wall Method
- E1877 Practice for Calculating Thermal Endurance of Materials from Thermogravimetric Decomposition Data
- E1970 Practice for Statistical Treatment of Thermoanalytical Data
- E2040 Test Method for Mass Scale Calibration of Thermogravimetric Analyzers
- E2550 Test Method for Thermal Stability by Thermogravimetry

3. Terminology

3.1 *Definitions*—Technical terms used in this test method defined in Terminologies E473 and E1142 include *Arrhenius equation*, *activation energy*, *Celsius*, *failure criterion*, *pre-exponential factor*, *reaction order*, and *thermogravimetric analysis*.

4. Summary of Test Method

4.1 These test methods consist of heating a test specimen weighing a few milligrams at a heating rate of about 1 K/min with a superimposed step-and-hold (factor jump) or sinusoidal (modulated) temperature program through the decomposition temperature region. The specimen mass rate-of-change is continuously calculated and recorded as a function of temperature. The activation energy is then determined from the mass rate-of-change at two (or more) closely spaced temperature regions. The activation energy thus determined is based on no assumed reaction model or mechanism and thus is model free.

4.2 Assuming a first-order reaction model ($n = 1$), the additional reaction parameter logarithm-of-the-pre-exponential-factor ($\ln[Z]$) is additionally determined.

4.3 Activation energy and logarithm-of-the-pre-exponential-factor may be displayed as a function of average temperature or conversion to provide additional information about the constancy of the decomposition reaction relative to these experimental parameters.

5. Significance and Use

5.1 The activation energy may be used to calculate thermal endurance and an estimate of the lifetime of the material at specified temperatures using Test Method E1877.