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**Plastics - Thermogravimetry (TG) of polymers - Part 1: General
principles**

塑料 聚合物热重法 (TG) 第1部分: 通则

(English Translation)

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1 Scope

This document describes general procedures for the analysis of polymers using thermogravimetry, to measure the decomposition temperature and rate of polymers, as well as the amounts of volatiles, additives, and/or fillers.

This document applies to the analysis of liquid or solid samples, and also to the analysis of appropriately sized molded products.

This document presents various methods for studying the relationship between mass changes and physical effects and chemical reactions.

Thermogravimetry includes dynamic mode (mass changes with temperature or time under programmed control) or isothermal mode (mass changes with time at a constant temperature).

Thermogravimetry can be performed in various atmospheres, such as inert atmospheres, to avoid the effects of oxidative degradation reactions.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 2035, Plastics - Vocabulary (GB/T 2035-2024, ISO 472:2013, NEQ)

GB/T 2918, Plastics - Standard atmospheres for conditioning and testing (GB/T 2918-2018, ISO 291:2008, MOD)

3 Terms and definitions

For the purposes of this document, the following terms and definitions, as well as those given in GB/T 2035, apply.

3.1

dynamic mass-change determination

A technique for recording the change of sample mass with temperature T under programmed temperature rate control.

3.2

isothermal mass-change determination

A technique for recording the change of sample mass with time t at a constant temperature T .

3.3

Curie temperature

The critical temperature at which a magnetic material transitions from a ferromagnetic state to a paramagnetic state, and vice versa.

4 Principle

Heat the sample at a set rate under programmed temperature control, and measure the change in mass with temperature (dynamic mass-change determination). Alternatively, hold the sample at a constant temperature, and measure the change in mass with time (isothermal mass-change determination).

During the measurement, the sample shall be kept in an inert, oxygen, or other reactive atmosphere.

Generally, decomposition reactions, oxidation reactions, or component volatilization will cause changes in sample mass. In some cases, special reactive gases may also be used

for measurement.

The change in mass with temperature and/or time is recorded as a thermogravimetric (TG) curve.

For materials, whose mass is a function of temperature, the extent of mass change reflects the material's thermal stability. Therefore, under the same test conditions, the measured TG data can be used to evaluate the relative thermal stability of polymers of the same type, as well as polymer-polymer or polymer-additive interactions.

Note: TG data can be used for process control, process improvement, and material evaluation. The long-term thermal stability of a polymer is influenced by the combined effects of service conditions and environmental conditions and cannot be evaluated solely on the basis of TG data.

5.1 Thermobalance

It shall meet the following requirements.

- It shall have a constant heating or cooling rate;
- The test temperature shall remain constant (temperature variation not exceeding ± 0.3 K during continuous measurement);
- The purge gas flow rate shall be stable, with fluctuations not exceeding $\pm 10\%$ (e.g., 10 mL/min $\sim$ 150 mL/min);
- The temperature range and mass range shall meet the test requirements;
- It shall automatically record the mass change curves against temperature and time;

Note: Some instruments can also display the derivative thermogravimetric (DTG) curve, which is helpful for data analysis.

- The accuracy of temperature signal measurement shall be $\pm 1\%$ of the measured absolute temperature or better;
- The accuracy of time measurement shall be ± 1 s or better;
- The accuracy of mass measurement shall be ± 20 μ g or better.

5.2 Purge gas

The purge gas under oxidizing conditions shall be dry air or oxygen; the purge gas under non-oxidizing conditions shall be a suitable inert gas with an oxygen content below 0.001% (volume fraction). The moisture content in the purge gas shall be less than 0.001% (mass fraction).

6.1 General

The test sample may be in the form of a liquid, powder, sphere, granule, sheet, or any other suitable solid form and size. For finished products, the test sample shall be obtained directly from the product by machining.

6.2 Preparation of test samples from finished products

Cut the test sample using a slicer or a blade. The dimensions of the sample shall be compatible with the crucible used.

Note: The dimensions and shape of the test sample generally depend on the crucible.

The surface area of the test sample may affect the test results. For test samples of the same mass, those with a larger surface area generally exhibit a higher rate of change than those with a smaller surface area.

6.3 Sample conditioning

Unless otherwise specified, the test sample shall be conditioned in accordance with

GB/T 2918 at a temperature of (23 ± 2) °C and a relative humidity of (50 ± 10) %, or under other conditions as agreed upon by the interested parties.

6.4 Sample mass

The sample mass shall be appropriate for the selected test method and shall be within the weighing capacity of the thermobalance.

7.1 Mass calibration

Calibrate the thermobalance under static purge gas conditions. Select a calibration mass within the measurement range, and calibrate the thermobalance as follows.

Calibrate the thermobalance using calibrated weights in accordance with the instrument's instruction manual, and record the temperature at which the calibration is performed. If mass calibration is performed by a calibration service provider, the validity of the mass calibration may be confirmed by means of a valid calibration certificate issued by that provider.

Note: Static purge gas conditions are used to eliminate interference caused by buoyancy resulting from gas flow.

7.2 Temperature calibration

Calibrate the temperature using the same gas, gas flow rate and heating rate as those used in the actual measurement (see Chapter 8).