Designation: D2799 – 23

Standard Test Method for Microscopical Determination of the Maceral Composition of Coal[1]

This standard is issued under the fixed designation D2799; 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 test method covers the equipment and techniques used for determining the physical composition of a coal sample in terms of volume fraction of the organic components and of mineral matter, if desired by systematic manual point count.

1.2 The term *weight* is temporarily used in this test method because of established trade usage. The word is used to mean both force and mass and care must be taken to determine which is meant in each case (the SI unit for force is newton and for mass, kilogram).

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D121 Terminology of Coal and Coke
D388 Classification of Coals by Rank
D2797 Practice for Preparing Coal Samples for Microscopical Analysis by Reflected Light
D2798 Test Method for Microscopical Determination of the Vitrinite Reflectance of Coal
D3174 Test Method for Ash in the Analysis Sample of Coal and Coke from Coal
D4239 Test Method for Sulfur in the Analysis Sample of Coal and Coke Using High-Temperature Tube Furnace Combustion
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E562 Test Method for Determining Volume Fraction by Systematic Manual Point Count
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions*—For definitions of terms, refer to Terminology D121.

3.2 *Classification*—The classification of the microscopic constituents into groups of similar properties in a given coal is as follows:

Maceral Group	Maceral
Vitrinite	—
Liptinite	alginite
	cutinite
	resinite
	sporinite
Inertinite	fusinite
	inertodetrinite
	macrinite
	micrinite
	funginite
	secretinite
	semifusinite

3.3 Many laboratories associated with the coke-making industry use the following simplified classification for petrographic analysis of bituminous coal:

Maceral Group	Maceral
Vitrinite	vitrinite
Liptinite	liptinite (other than resinite)
	resinite
Inertinite	semifusinite
	micrinite
	fusinite
	mineral matter

Other organizations use different classifications.

3.4 *Definitions of Terms Specific to This Standard:*

3.4.1 *alginite, n*—a liptinite maceral that is generally spherical or ovoid, frequently having a crenulated border and somewhat irregular reflectance and sometimes occurring in clusters reflecting an origin from *Botryococcus* algae.

[1] This test method is under the jurisdiction of ASTM Committee D05 on Coal and Coke and is the direct responsibility of Subcommittee D05.28 on Petrographic Analysis of Coal and Coke.

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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.

3.4.1.1 *Discussion*—Alginite often occurs as degraded fragments derived from colonial or unicellular bodies.

3.4.2 *cutinite, n*—a liptinite maceral in the form of a sheet reflecting its origin from leaf- or twig-covering plant cuticle, frequently exhibiting reticulation in planar section and a serrated edge in cross section.

3.4.3 *exinite, n*—Deprecated term. Use preferred term **liptinite**; sometimes has also been used as a synonym for sporinite.

3.4.4 *funginite, n*—an inertinite maceral occurring as round or ovoid bodies, frequently containing voids, reflecting an origin from fungal sclerotia; also occurs (especially in lower rank coals) as interlaced, stringy materials derived from fungal hyphae.

3.4.5 *fusinite, n*—an inertinite maceral distinguished principally by the preservation of some feature(s) of the plant cell wall structure, and with a particle size greater than 50 µm except when it occurs as a fragment within the binder matrix; see also **semifusinite**.

3.4.6 *inertinite, n*—macerals that exhibit higher reflectance than other organic substances in the coal.

3.4.6.1 *Discussion*—In any coal ranked lower than anthracitic, inertinite reflectance commonly spans the range from only slightly higher than associated vitrinite to very high reflectance (often as high as $R_o max \geq 6$ %). In anthracitic rank coals, inertinite reflectance may be lower than that of vitrinite, and is then recognized by its morphology and form of anisotropy. Highly reflecting inertinite commonly exhibits relief on polished surface. Its name derives from the fact that most varieties behave inertly in the thermoplastic deformation during the coking process (except in its lowest reflecting manifestation). The volatile matter yield of inertinite is lower than that of other macerals in the same coal.

3.4.7 *inertodetrinite, n*—an inertinite maceral occurring as individual, angular, clastic fragments incorporated within the matrix of other macerals (commonly vitrinite) or minerals, and in the size range from 2 µm to 50 µm.

3.4.8 *liptinite, n*—macerals that exhibit lower reflectance than other organic substances in a coal, appearing black to dark gray and that fluoresce under blue to ultraviolet light in coals ranked high volatile bituminous and lower.

3.4.8.1 *Discussion*—The fluorescence of liptinite distinguishes fine-grained liptinite from similar sized, low reflectance, nonfluorescing clay minerals. Liptinite is derived principally from lipid substances forming skins (exines) and resinous secretions or exudates of plants. Liptinite is subclassified on the basis of morphology inherited from plant structure. In coals in which vitrinite reflectance exceeds about 1.4 %, liptinite can be indistinguishable from vitrinite. Liptinite has the highest volatile matter yield of the macerals in a coal.

3.4.9 *maceral, n*—an organic substance in coal that is distinguished and classified (see **maceral classification**) on the basis of its optical microscopic properties.

3.4.9.1 *Discussion*—Macerals originate from plant tissues, secretions, and exudates that have been altered by geological processes and may contain up to several weight percent of inorganic elements in microscopically indistinguishable form.

3.4.10 *maceral classification, n*—The systematic division of the organic substances (macerals) in coal based on their appearance in the optical microscopic.

3.4.10.1 *Discussion*—Although macerals may be identified in translucent, thin sections using criteria not defined herein, this test method deals only with identification and classification based on microscopic appearance on polished surfaces according to Practice D2797. Three major maceral groups are recognized on the basis of relative reflectance in white light, specifically: vitrinite—moderately reflecting (intermediate gray), liptinite—poorly reflecting (black to dark gray), and inertinite—highly reflecting (light gray to white). Each group can be subdivided on the basis of other microscopically distinctive features such as: reflectance contrasts (relative shades of gray); morphology, that is, shape and size (morphologic distinctions in definitions contained herein are idealized because morphologic appearance depends on the initial form of the source material, its state of preservation, including granulation, and on the orientation of the cross section presented on the polished preparation); spatial association with other substances; fluorescence properties (color, intensity) in blue to ultraviolet light; relief; color tinges; internal reflections; and anisotropic properties.

Microscopic criteria provide classification capability without any implication of absolute chemical composition or physical behavior, although some properties relative to other macerals in the same coal can be inferred broadly. Substances classified as the same maceral by microscopic criteria can differ chemically, physically, and characteristically in coals of different ranks. Some properties can be estimated by the measurement of reflectance (Test Method D2798).

See 3.3 for the classification used by most practitioners of this test method.

3.4.11 *macrinite, n*—an inertinite maceral, generally nonangular, exhibiting no relict plant cell wall structure and larger than 10 µm.

3.4.12 *micrinite, n*—an inertinite maceral, generally nonangular, exhibiting no relict plant cell wall structure, smaller than 10 µm and most commonly occurring as particles around 1 µm to 5 µm diameter.

3.4.13 *mineral matter, n—in coal*, historically considered to be the non-organic fraction composed of physically discrete particles of minerals, such as clays, quartz, pyrite, etc., and all elements other than, carbon, hydrogen, oxygen, nitrogen, and sulfur in the organic fraction.

3.4.14 *resinite, n*—a liptinite maceral occurring as rounded, ovoid, or rod-like bodies assuming the shape of an enclosing cell lumen or as irregular shapes filling cracks in the coal.

3.4.15 *secretinite, n*—an inertinite maceral occurring as round, ovoid, or oblong bodies, without obvious plant structure, vesicled to non-vesicled, sometimes containing characteristic fractures, slits, or a notch.

3.4.15.1 *Discussion*—Secretinite is considered to be derived by the oxidation of plant resin secretions or humic gels. Vesicular and non-vesicular secretinite was formerly included