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.

Designation: C1835 – 16 (Reapproved 2023)

Standard Classification for Fiber Reinforced Silicon Carbide-Silicon Carbide (SiC-SiC) Composite Structures[1]

This standard is issued under the fixed designation C1835; 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 classification covers silicon carbide-silicon carbide (SiC-SiC) composite structures (flat plates, rectangular bars, round rods, and tubes) manufactured for structural components. The SiC-SiC composites consist of continuous silicon carbide fibers in a silicon carbide matrix produced by four different matrix densification methods.

1.2 The classification system provides a means of identifying and organizing different SiC-SiC composites, based on the fiber type, architecture class, matrix densification, physical properties, and mechanical properties. The system provides a top-level identification system for grouping different types of SiC-SiC composites into different classes and provides a means of identifying the general structure and properties of a given SiC-SiC composite. It is meant to assist the ceramics community in developing, selecting, and using SiC-SiC composites with the appropriate composition, construction, and properties for a specific application.

1.3 The classification system produces a classification code for a given SiC-SiC composite, which shows the type of fiber, reinforcement architecture, matrix type, fiber volume fraction, density, porosity, and tensile strength and modulus (room temperature).

1.3.1 For example, Composites Classification Code, *SC2-A2C-4D10-33*—a SiC-SiC composite material/component (*SC2*) with a 95 %+ polymer precursor (*A*) based silicon carbide fiber in a 2-D (*2*) fiber architecture with a CVI matrix (*C*), a fiber volume fraction of 45 % (*4* = 40 % to 45 %), a bulk density of 2.3 g/cc (*D* = 2.0 g⁄cc to 2.5 g/cc), an apparent porosity of 12 % (*10* = 10 % to 15 %), an average ultimate tensile strength of 350 MPa (*3* = 300 MPa to 399 MPa), and an average tensile modulus of 380 GPa (*3* = 300 GPa to 399 GPa).

1.4 This classification system is a top level identification tool which uses a limited number of composite properties for high level classification. It is not meant to be a complete, detailed material specification, because it does not cover the full range of composition, architecture, physical, mechanical, fabrication, and durability requirements commonly defined in a full design specification. Guide C1793 provides extensive and detailed direction and guidance in preparing a complete material specification for a given SiC-SiC composite component.

1.5 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *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]

C242 Terminology of Ceramic Whitewares and Related Products

C559 Test Method for Bulk Density by Physical Measurements of Manufactured Carbon and Graphite Articles

C1039 Test Methods for Apparent Porosity, Apparent Specific Gravity, and Bulk Density of Graphite Electrodes

C1145 Terminology of Advanced Ceramics

C1198 Test Method for Dynamic Young's Modulus, Shear Modulus, and Poisson's Ratio for Advanced Ceramics by Sonic Resonance

C1259 Test Method for Dynamic Young's Modulus, Shear Modulus, and Poisson's Ratio for Advanced Ceramics by Impulse Excitation of Vibration

C1275 Test Method for Monotonic Tensile Behavior of

[1] This classification is under the jurisdiction of ASTM Committee C28 on Advanced Ceramics and is the direct responsibility of Subcommittee C28.07 on Ceramic Matrix Composites.

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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.

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Continuous Fiber-Reinforced Advanced Ceramics with Solid Rectangular Cross-Section Test Specimens at Ambient Temperature
C1773 Test Method for Monotonic Axial Tensile Behavior of Continuous Fiber-Reinforced Advanced Ceramic Tubular Test Specimens at Ambient Temperature
C1793 Guide for Development of Specifications for Fiber Reinforced Silicon Carbide-Silicon Carbide Composite Structures for Nuclear Applications
D3878 Terminology for Composite Materials
D4850 Terminology Relating to Fabrics and Fabric Test Methods
D6507 Practice for Fiber Reinforcement Orientation Codes for Composite Materials
E6 Terminology Relating to Methods of Mechanical Testing
E111 Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus
E1309 Guide for Identification of Fiber-Reinforced Polymer-Matrix Composite Materials in Databases (Withdrawn 2015)[3]

3. Terminology

3.1 *General Definitions*—Many of the terms in this classification are defined in the terminology standards for ceramic whitewares (C242), advanced ceramics (C1145), composite materials (D3878), fabrics and fabric test methods (D4850), and mechanical testing (E6).

3.1.1 *apparent porosity, n*—the volume fraction of all pores, voids, and channels within a solid mass that are interconnected with each other and communicate with the external surface, and thus are measurable by gas or liquid penetration. (Synonym – open porosity) **C242**

3.1.2 *braided fabric, n*—a woven structure produced by interlacing three or more ends of yarns in a manner such that the paths of the yarns are diagonal to the vertical axis of the fabric.

3.1.2.1 *Discussion*—Braided structures can have 2-D or 3-D architectures. **D4850**

3.1.3 *bulk density, n*—the mass of a unit volume of material including both permeable and impermeable voids. **C559**

3.1.4 *ceramic matrix composite, n*—a material consisting of two or more materials (insoluble in one another), in which the major, continuous component (matrix component) is a ceramic, while the secondary component(s) (reinforcing component) may be ceramic, glass-ceramic, glass, metal, or organic in nature. These components are combined on a macroscale to form a useful engineering material possessing certain properties or behavior not possessed by the individual constituents. **C1145**

3.1.5 *fabric, n—in textiles*, a planar structure consisting of yarns or fibers. **D4850**

3.1.6 *fiber, n*—a fibrous form of matter with an aspect ratio >10 and an effective diameter <1 mm. (Synonym – filament)

3.1.6.1 *Discussion*—A fiber/filament forms the basic element of fabrics and other textile structures. **D3878**

3.1.7 *fiber fraction (volume or weight), n*—the amount of fiber present in a composite, expressed either as a percent by weight or a percent by volume. **D3878**

3.1.8 *fiber preform, n*—a preshaped fibrous reinforcement, normally without matrix, but often containing a binder to facilitate manufacture, formed by distribution/weaving of fibers to the approximate contour and thickness of the finished part. **D3878**

3.1.9 *hybrid, n—for composite materials*, containing at least two distinct types of matrix or reinforcement. Each matrix or reinforcement type can be distinct because of its *(a)* physical or mechanical properties, or both, *(b)* material form, or *(c)* chemical composition. **D3878**

3.1.10 *knitted fabric, n*—a fiber structure produced by interlooping one or more ends of yarn or comparable material. **D4850**

3.1.11 *laminate, n*—any fiber- or fabric-reinforced composite consisting of laminae (plies) with one or more orientations with respect to some reference direction. **D3878**

3.1.12 *lay-up, n*—a process or fabrication involving the placement of successive layers of materials in specified sequence and orientation. **D6507, E1309**

3.1.13 *matrix, n*—the continuous constituent of a composite material, which surrounds or engulfs the embedded reinforcement in the composite and acts as the load transfer mechanism between the discrete reinforcement elements. **D3878**

3.1.14 *ply, n—in 2-D laminar composites*, the constituent single layer as used in fabricating, or occurring within, a composite structure. **D3878**

3.1.15 *tow, n—in fibrous composites*, a continuous, ordered assembly of essentially parallel, collimated continuous filaments, normally without twist. (Synonym – roving) **D3878**

3.1.16 *unidirectional composite, n*—any fiber reinforced composite with all fibers aligned in a single direction. **D3878**

3.1.17 *woven fabric, n*—a fabric structure produced by the interlacing, in a specific weave pattern, of tows or yarns oriented in two or more directions.

3.1.17.1 *Discussion*—There are a large variety of 2-D weave styles, e.g., plain, satin, twill, basket, crowfoot, etc.

3.1.18 *yarn, n—in fibrous composites*, a continuous, ordered assembly of essentially parallel, collimated filaments, normally with twist, and of either discontinuous or continuous filaments.

3.1.18.1 *single yarn, n*—an end in which each filament follows the same twist. **D3878**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *1-D, 2-D, and 3-D reinforcement, n*—a description of the orientation and distribution of the reinforcing fibers and yarns in a composite.

3.2.1.1 *Discussion*—In a 1-D structure, all of the fibers are oriented in a single longitudinal (x) direction. In a 2-D structure, all of the fibers lie in the x-y planes of the plate or bar or in the circumferential shells (axial and circumferential directions) of the rod or tube with no fibers aligned in the z or

[3] The last approved version of this historical standard is referenced on www.astm.org.