



Designation: C1783 – 15 (Reapproved 2024)

## Standard Guide for Development of Specifications for Fiber Reinforced Carbon- Carbon Composite Structures for Nuclear Applications<sup>1</sup>

This standard is issued under the fixed designation C1783; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This document is a guide to preparing material specifications for fiber reinforced carbon-carbon (C-C) composite structures (flat plates, rectangular bars, round rods, and tubes) manufactured specifically for structural components in nuclear reactor core applications. The carbon-carbon composites consist of carbon/graphite fibers (from PAN, pitch, or rayon precursors) in a carbon/graphite matrix produced by liquid infiltration/pyrolysis and/or by chemical vapor infiltration.

1.2 This guide provides direction and guidance for the development of a material specification for a specific C-C composite component or product for nuclear reactor applications. The guide considers composite constituents and structure, physical and chemical properties, mechanical properties, thermal properties, performance durability, methods of testing, materials and fabrication processing, and quality assurance. The C-C composite materials considered here would be suitable for nuclear reactor core applications where neutron irradiation-induced damage and dimensional changes are a significant design consideration. **(1-4)**<sup>2</sup>

1.3 The component specification is to be developed by the designer/purchaser/user. The designer/purchaser/user shall define and specify in detail any and all application-specific requirements for necessary design, manufacturing, and performance factors of the ceramic composite component. This guide for material specifications does not directly address component/product-specific issues, such as geometric tolerances, permeability, bonding, sealing, attachment, and system integration.

1.4 This guide is specifically focused on C-C composite components and structures with flat panel, solid rectangular bar, solid round rod, or tubular geometries.

<sup>1</sup> This guide 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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<sup>2</sup> The boldface numbers in parentheses refer to the list of references at the end of this standard.

1.5 This specification may also be applicable to C-C composites used for other structural applications discounting the nuclear-specific chemical purity and irradiation behavior factors.

1.6 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *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.*

1.8 *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*:<sup>3</sup>

C242 Terminology of Ceramic Whitewares and Related Products

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

C561 Test Method for Ash in a Graphite Sample

C577 Test Method for Permeability of Refractories

C611 Test Method for Electrical Resistivity of Manufactured Carbon and Graphite Articles at Room Temperature

C625 Practice for Reporting Irradiation Results on Graphite

C709 Terminology Relating to Manufactured Carbon and Graphite (Withdrawn 2017)<sup>4</sup>

C714 Guide for Thermal Diffusivity of Carbon and Graphite by Thermal Pulse Method

C769 Test Method for Sonic Velocity in Manufactured Carbon and Graphite Materials for Use in Obtaining an

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>4</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

- Approximate Value of Young's Modulus
- C816** Test Method for Sulfur Content in Graphite by Combustion-Iodometric Titration Method
- C838** Test Method for Bulk Density of As-Manufactured Carbon and Graphite Shapes
- C1039** Test Methods for Apparent Porosity, Apparent Specific Gravity, and Bulk Density of Graphite Electrodes
- C1179** Test Method for Oxidation Mass Loss of Manufactured Carbon and Graphite Materials in Air
- C1198** Test Method for Dynamic Young's Modulus, Shear Modulus, and Poisson's Ratio for Advanced Ceramics by Sonic Resonance
- C1233** Practice for Determining Equivalent Boron Contents of Nuclear Materials
- C1239** Practice for Reporting Uniaxial Strength Data and Estimating Weibull Distribution Parameters for Advanced Ceramics
- C1259** Test Method for Dynamic Young's Modulus, Shear Modulus, and Poisson's Ratio for Advanced Ceramics by Impulse Excitation of Vibration
- C1274** Test Method for Advanced Ceramic Specific Surface Area by Physical Adsorption
- C1275** Test Method for Monotonic Tensile Behavior of Continuous Fiber-Reinforced Advanced Ceramics with Solid Rectangular Cross-Section Test Specimens at Ambient Temperature
- C1291** Test Method for Elevated Temperature Tensile Creep Strain, Creep Strain Rate, and Creep Time to Failure for Monolithic Advanced Ceramics
- C1292** Test Method for Shear Strength of Continuous Fiber-Reinforced Advanced Ceramics at Ambient Temperatures
- C1337** Test Method for Creep and Creep Rupture of Continuous Fiber-Reinforced Advanced Ceramics Under Tensile Loading at Elevated Temperatures
- C1341** Test Method for Flexural Properties of Continuous Fiber-Reinforced Advanced Ceramic Composites
- C1358** Test Method for Monotonic Compressive Strength Testing of Continuous Fiber-Reinforced Advanced Ceramics with Solid Rectangular Cross Section Test Specimens at Ambient Temperatures
- C1359** Test Method for Monotonic Tensile Strength Testing of Continuous Fiber-Reinforced Advanced Ceramics With Solid Rectangular Cross Section Test Specimens at Elevated Temperatures
- C1360** Practice for Constant-Amplitude, Axial, Tension-Tension Cyclic Fatigue of Continuous Fiber-Reinforced Advanced Ceramics at Ambient Temperatures
- C1425** Test Method for Interlaminar Shear Strength of 1D and 2D Continuous Fiber-Reinforced Advanced Ceramics at Elevated Temperatures
- C1468** Test Method for Transthickness Tensile Strength of Continuous Fiber-Reinforced Advanced Ceramics at Ambient Temperature
- C1470** Guide for Testing the Thermal Properties of Advanced Ceramics
- C1525** Test Method for Determination of Thermal Shock Resistance for Advanced Ceramics by Water Quenching
- C1557** Test Method for Tensile Strength and Young's Modulus of Fibers
- C1683** Practice for Size Scaling of Tensile Strengths Using Weibull Statistics for Advanced Ceramics
- D2766** Test Method for Specific Heat of Liquids and Solids (Withdrawn 2018)<sup>4</sup>
- D3171** Test Methods for Constituent Content of Composite Materials
- D3529/D3529M** Test Methods for Constituent Content of Composite Prepreg
- D3800** Test Method for Density of High-Modulus Fibers
- D3878** Terminology for Composite Materials
- D4018** Test Methods for Properties of Continuous Filament Carbon and Graphite Fiber Tows
- D4284** Test Method for Determining Pore Volume Distribution of Catalysts and Catalyst Carriers by Mercury Intrusion Porosimetry
- D4850** Terminology Relating to Fabrics and Fabric Test Methods
- D5528** Test Method for Mode I Interlaminar Fracture Toughness of Unidirectional Fiber-Reinforced Polymer Matrix Composites
- D5600** Test Method for Trace Metals in Petroleum Coke by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)
- D5766** Test Method for Open-Hole Tensile Strength of Polymer Matrix Composite Laminates
- D5961** Test Method for Bearing Response of Polymer Matrix Composite Laminates
- D6484** Test Method for Open-Hole Compressive Strength of Polymer Matrix Composite Laminates
- D6507** Practice for Fiber Reinforcement Orientation Codes for Composite Materials
- D6671** Test Method for Mixed Mode I-Mode II Interlaminar Fracture Toughness of Unidirectional Fiber Reinforced Polymer Matrix Composites
- D7136** Test Method for Measuring the Damage Resistance of a Fiber-Reinforced Polymer Matrix Composite to a Drop-Weight Impact Event
- D7137** Test Method for Compressive Residual Strength Properties of Damaged Polymer Matrix Composite Plates
- D7219** Specification for Isotropic and Near-isotropic Nuclear Graphites
- D7542** Test Method for Air Oxidation of Carbon and Graphite in the Kinetic Regime
- E6** Terminology Relating to Methods of Mechanical Testing
- E111** Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus
- E132** Test Method for Poisson's Ratio at Room Temperature
- E143** Test Method for Shear Modulus at Room Temperature
- E228** Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer
- E261** Practice for Determining Neutron Fluence, Fluence Rate, and Spectra by Radioactivation Techniques
- E289** Test Method for Linear Thermal Expansion of Rigid Solids with Interferometry
- E408** Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques