



Standard Test Method for Hoop Tensile Strength of Continuous Fiber-Reinforced Advanced Ceramic Composite Tubular Test Specimens at Ambient Temperature Using Elastomeric Inserts¹

This standard is issued under the fixed designation C1819; 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 determination of the hoop tensile strength including stress-strain response of continuous fiber-reinforced advanced ceramic tubes subjected to an internal pressure produced by the expansion of an elastomeric insert undergoing monotonic uniaxial loading at ambient temperature. This type of test configuration is sometimes referred to as an overhung tube. This test method is specific to tube geometries, because flaw populations, fiber architecture and specimen geometry factors are often distinctly different in composite tubes, as compared to flat plates.

1.2 In the test method a composite tube/cylinder with a defined gage section and a known wall thickness is loaded via internal pressurization from the radial expansion of an elastomeric insert (located midway inside the tube) that is longitudinally compressed from either end by pushrods. The elastomeric insert expands under the uniaxial compressive loading of the pushrods and exerts a uniform radial pressure on the inside of the tube. The resulting hoop stress-strain response of the composite tube is recorded until failure of the tube. The hoop tensile strength and the hoop fracture strength are determined from the resulting maximum pressure and the pressure at fracture, respectively. The hoop tensile strains, the hoop proportional limit stress, and the modulus of elasticity in the hoop direction are determined from the stress-strain data. Note that hoop tensile strength as used in this test method refers to the tensile strength in the hoop direction from the induced pressure of a monotonic, uniaxially-loaded elastomeric insert where monotonic refers to a continuous nonstop test rate without reversals from test initiation to final fracture.

1.3 This test method applies primarily to advanced ceramic matrix composite tubes with continuous fiber reinforcement: uni-directional (1-D, filament wound and tape lay-up), bidirectional (2-D, fabric/tape lay-up and weave), and tridirectional (3-D, braid and weave). These types of ceramic matrix com-

posites can be composed of a wide range of ceramic fibers (oxide, graphite, carbide, nitride, and other compositions) in a wide range of crystalline and amorphous ceramic matrix compositions (oxide, carbide, nitride, carbon, graphite, and other compositions).

1.4 This test method does not directly address discontinuous fiber-reinforced, whisker-reinforced or particulate-reinforced ceramics, although the test methods detailed here may be equally applicable to these composites.

1.5 The test method is applicable to a range of test specimen tube geometries based on a non dimensional parameter that includes composite material property and tube radius. Lengths of the composite tube, push rods and elastomeric insert are determined from this non dimensional parameter so as to provide a gage length with uniform, internal, radial pressure. A wide range of combinations of material properties, tube radii, wall thicknesses, tube lengths and insert lengths are possible.

1.5.1 This test method is specific to ambient temperature testing. Elevated temperature testing requires high temperature furnaces and heating devices with temperature control and measurement systems and temperature-capable grips and loading fixtures, which are not addressed in this test standard.

1.6 This test method addresses tubular test specimen geometries, test specimen methods, testing rates (force rate, induced pressure rate, displacement rate, or strain rate), and data collection and reporting procedures in the following sections.

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¹ This test method 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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