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CMC airfoil with cooling passage formed in fiber plies

Abstract

An airfoil includes a platform and an airfoil section that are formed of a ceramic matrix composite that includes core fiber plies, skin fiber plies, platform fiber plies, and a cooling passage that extends through selected ones of the plies to provide a cooling circuit through the airfoil section and into the platform.

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Background/Summary

BACKGROUND

(1) A gas turbine engine typically includes a fan section, a compressor section, a combustor section and a turbine section. Air entering the compressor section is compressed and delivered into the combustion section where it is mixed with fuel and ignited to generate a high-pressure and temperature core gas flow. The high-pressure and temperature core gas flow expands through the turbine section to drive the compressor and the fan section. The compressor section may include low and high pressure compressors, and the turbine section may also include low and high pressure turbines.

(2) Airfoils in the turbine section are typically formed of a superalloy and may include thermal barrier coatings to extend temperature capability and lifetime. Ceramic matrix composite (“CMC”) materials are also being considered for airfoils. Among other attractive properties, CMCs have high temperature resistance. Despite this attribute, however, there are unique challenges to implementing CMCs in airfoils.

SUMMARY

(3) An airfoil according to an example of the present disclosure includes a platform and an airfoil section that are formed of a ceramic matrix composite that includes core fiber plies, skin fiber plies, platform fiber plies, and a cooling passage that extends through selected ones of the plies to

provide a cooling circuit through the airfoil section and into the platform.
(4) In a further example of the foregoing embodiment, the airfoil passage section is bound, relative to the internal cavity, on an inner side and on lateral sides by the at least one intermediate core fiber ply, and is bound on an outer side by one of the skin fiber plies.
(5) In a further example of any of the foregoing embodiments, the at least one inlet orifice extends through at least one of the intermediate core fiber plies.
(6) In a further example of any of the foregoing embodiments, with respect to radial proximity to the gaspath side, the platform fiber plies include first and second platform fiber plies, and at least one intermediate platform fiber ply between the first and second platform fiber plies, and the platform passage section is bound on a first platform passage side by one of the skin fiber plies, is bound on lateral sides by another of the skin fiber plies and by the first platform fiber ply, and is bound on a second platform passage side by one of the intermediate platform fiber plies.
(7) In a further example of any of the foregoing embodiments, in the platform passage section includes a first leg that extends away from the airfoil section, and a second leg that curves around a leading edge of the airfoil section.
(8) In a further example of any of the foregoing embodiments, the airfoil passage section is bound on an inner side and on lateral sides by the at least one intermediate core fiber ply and is bound on an outer side by one of the skin fiber plies, the at least one inlet orifice extends through at least one of the intermediate core fiber plies, with respect to radial proximity to the gaspath side, the platform fiber plies include first and second platform fiber plies, and at least one intermediate platform fiber ply between the first and second platform fiber plies, and the platform passage section is bound on a first platform passage side by one of the at least one intermediate platform fiber plies, is bound on lateral sides by the first platform fiber ply and by the at least one intermediate platform fiber ply, and is bound on a second platform passage side by one of the skin fiber plies.
(9) A further example of any of the foregoing embodiments includes a bypass inlet orifice in the platform, the bypass inlet orifice opening to the platform passage section and connecting the internal cavity with the platform passage section to bypass flow through the airfoil passage section.
(10) In a further example of any of the foregoing embodiments, the at least one cooling passage includes first and second cooling passages extending through, respectively, a suction side wall and a pressure side wall of the airfoil section.
(11) In a further example of any of the foregoing embodiments, the first and second cooling passages are symmetric to each other.
(12) In a further example of any of the foregoing embodiments, the airfoil is in a turbine section of a gas turbine engine.
(13) The present disclosure may include any one or more of the individual features disclosed above and/or below alone or in any combination thereof.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The various features and advantages of the present disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.
(2) FIG. **1** illustrates a gas turbine engine.
(3) FIG. **2** illustrates an airfoil from the engine.
(4) FIG. **3**A illustrates fiber plies of the airfoil.
(5) FIG. **3**B illustrates an enlarged view of the fiber plies.
(6) FIG. **4** illustrates the airfoil with several skin plies excluded so that a cooling passage is visible.

(7) FIG. **5** illustrates a section of a cooling passage in the platform of the airfoil.
(8) FIG. **6** illustrates a sectioned view through the platform.
(9) FIG. **7** illustrates an example airfoil that additionally has a bypass inlet orifice.
(10) FIG. **8** illustrates an example airfoil that additionally has a second, symmetrical cooling passage.
(11) FIG. **9** illustrates an example method for fabricating an airfoil.
(12) In this disclosure, like reference numerals designate like elements where appropriate and reference numerals with the addition of one-hundred or multiples thereof designate modified elements that are understood to incorporate the same features and benefits of the corresponding elements. Terms such as "first" and "second," if used, are to differentiate that there are two architecturally distinct components or features. Furthermore, the terms "first" and "second" are interchangeable in that a first component or feature could alternatively be termed as the second component or feature, and vice versa.

DETAILED DESCRIPTION

(13) FIG. **1** schematically illustrates a gas turbine engine **20**. The gas turbine engine **20** is disclosed herein as a two-spool turbofan that generally incorporates a fan section **22**, a compressor section **24**, a combustor section **26** and a turbine section **28**. The fan section **22** drives air along a bypass flow path B in a bypass duct defined within a housing **15** such as a fan case or nacelle, and also drives air along a core flow path C for compression and communication into the combustor section **26** then expansion through the turbine section **28**. Although depicted as a two-spool turbofan gas turbine engine in the disclosed non-limiting embodiment, it should be understood that the concepts described herein are not limited to use with two-spool turbofans as the teachings may be applied to other types of turbine engines including three-spool architectures.
(14) The exemplary engine **20** generally includes a low speed spool **30** and a high speed spool **32** mounted for rotation about an engine central longitudinal axis A relative to an engine static structure **36** via several bearing systems **38**. It should be understood that various bearing systems **38** at various locations may alternatively or additionally be provided, and the location of bearing systems **38** may be varied as appropriate to the application.
(15) The low speed spool **30** generally includes an inner shaft **40** that interconnects, a first (or low) pressure compressor **44** and a first (or low) pressure turbine **46**. The inner shaft **40** is connected to the fan **42** through a speed change mechanism, which in exemplary gas turbine engine **20** is illustrated as a geared architecture **48** to drive a fan **42** at a lower speed than the low speed spool **30**. The high speed spool **32** includes an outer shaft **50** that interconnects a second (or high) pressure compressor **52** and a second (or high) pressure turbine **54**. A combustor **56** is arranged in the exemplary gas turbine **20** between the high pressure compressor **52** and the high pressure turbine **54**. A mid-turbine frame **57** of the engine static structure **36** may be arranged generally between the high pressure turbine **54** and the low pressure turbine **46**. The mid-turbine frame **57** further supports bearing systems **38** in the turbine section **28**. The inner shaft **40** and the outer shaft **50** are concentric and rotate via bearing systems **38** about the engine central longitudinal axis A which is collinear with their longitudinal axes.
(16) The core airflow is compressed by the low pressure compressor **44** then the high pressure compressor **52**, mixed and burned with fuel in the combustor **56**, then expanded through the high pressure turbine **54** and low pressure turbine **46**. The mid-turbine frame **57** includes airfoils **59** which are in the core airflow path C. The turbines **46**, **54** rotationally drive the respective low speed spool **30** and high speed spool **32** in response to the expansion. It will be appreciated that each of the positions of the fan section **22**, compressor section **24**, combustor section **26**, turbine section **28**, and fan drive gear system **48** may be varied. For example, gear system **48** may be located aft of the low pressure compressor, or aft of the combustor section **26** or even aft of turbine section **28**, and fan **42** may be positioned forward or aft of the location of gear system **48**.
(17) The engine **20** in one example is a high-bypass geared aircraft engine. In a further example,

the engine **20** bypass ratio is greater than about six (6), with an example embodiment being greater than about ten (10), and can be less than or equal to about 18.0, or more narrowly can be less than or equal to 16.0. The geared architecture **48** is an epicyclic gear train, such as a planetary gear system or other gear system, with a gear reduction ratio of greater than about 2.3. The gear reduction ratio may be less than or equal to 4.0. The low pressure turbine **46** has a pressure ratio that is greater than about five. The low pressure turbine pressure ratio can be less than or equal to 13.0, or more narrowly less than or equal to 12.0. In one disclosed embodiment, the engine **20** bypass ratio is greater than about ten (10:1), the fan diameter is significantly larger than that of the low pressure compressor **44**, and the low pressure turbine **46** has a pressure ratio that is greater than about five 5:1. Low pressure turbine **46** pressure ratio is pressure measured prior to an inlet of low pressure turbine **46** as related to the pressure at the outlet of the low pressure turbine **46** prior to an exhaust nozzle. The geared architecture **48** may be an epicycle gear train, such as a planetary gear system or other gear system, with a gear reduction ratio of greater than about 2.3:1 and less than about 5:1. It should be understood, however, that the above parameters are only exemplary of one embodiment of a geared architecture engine and that the present invention is applicable to other gas turbine engines including direct drive turbofans.
(18) A significant amount of thrust is provided by the bypass flow B due to the high bypass ratio. The fan section **22** of the engine **20** is designed for a particular flight condition—typically cruise at about 0.8 Mach and about 35,000 feet (10,668 meters). The flight condition of 0.8 Mach and 35,000 ft (10,668 meters), with the engine at its best fuel consumption—also known as “bucket cruise Thrust Specific Fuel Consumption (‘TSFC’)”—is the industry standard parameter of lbm of fuel being burned divided by lbf of thrust the engine produces at that minimum point. The engine parameters described above and those in this paragraph are measured at this condition unless otherwise specified. “Low fan pressure ratio” is the pressure ratio across the fan blade alone, without a Fan Exit Guide Vane (“FEGV”) system. The low fan pressure ratio as disclosed herein according to one non-limiting embodiment is less than about 1.45, or more narrowly greater than or equal to 1.25. “Low corrected fan tip speed” is the actual fan tip speed in ft/see divided by an industry standard temperature correction of [(Tram ° R)/(518.7° R)].sup.0.5. The “Low corrected fan tip speed” as disclosed herein according to one non-limiting embodiment is less than about 1150.0 ft/second (350.5 meters/second), and can be greater than or equal to 1000.0 ft/second (304.8 meters/second).
(19) FIG. **2** illustrates an airfoil **60** from the engine **20**. For example, the airfoil **60** is a turbine vane from the turbine section **28** of the engine **20**, and there are a plurality of turbine vanes arranged in a circumferential row in the turbine section **28**. The airfoil **60** is hollow and includes an airfoil section **62** and a platform **64**. The airfoil section **62** defines a leading edge **62***a*, a trailing edge **62***b*, a suction side **62***c*, and a pressure side **62***d*. The platform **64** includes a core gaspath side **64***a* and an opposite, non-core-gaspath side **64***b*. In the examples below, the platform is at a radially inner end of the airfoil section **62**, although it is to be understood that the platform **64** may alternatively be at the radially outer end, or the airfoil **60** may include an additional platform **64** at the radially outer end.
(20) The airfoil **60** is formed of a ceramic matrix composite (CMC) **65**. Referring to the cutaway section in FIG. **2**, the CMC **65** includes ceramic fibers **65***a* that are disposed in a ceramic matrix **65***b*. The CMC **65** may be, but is not limited to, a SiC/SiC composite in which SiC fibers are disposed within a SiC matrix. The ceramic fibers **65***a* are provided in fiber plies **66** that may be woven or braided and may collectively include plies of different fiber weave configurations.
(21) Referring to the view in FIG. **3**A, and the enlarged view in FIG. **3**B (inset from FIG. **2**), the fiber plies **66** include core fiber plies **68** and skin fiber plies **70**. The core fiber plies **68** define one or more radial tubes **72** that circumscribe one or more internal cavities **61**. The skin fiber plies **70** define the exterior profile of the airfoil **60** and wrap around the core fiber plies **68** from the pressure side **62***d* at the trailing edge **62***b*, through the leading edge **62***a*, and to the suction side **62***c* at the

trailing edge **62***b*. In the illustrated example, there are four core fiber plies **68** and three skin fiber plies **70**, although it is to be understood that the numbers of plies **68**/**70** can be varied.
(22) The core fiber plies **68** include, relative to the internal cavity, an innermost core fiber ply **68***a*, an outermost core fiber ply **68***b*, and at least one intermediate core fiber ply **68***c* (two shown) between the innermost core fiber ply **68***a* and the outermost core fiber ply **68***b*. Filler elements **74** are provided in interstitial regions where there is space between plies **66**, such as near the trailing edge **62***b* and at the end of a rib **75** in the airfoil **60** where the plies **66** turn. For example, the filler elements **74** are prefabricated monolithic or CMC pieces. In this example (see FIG. **2**), two of the skin plies **70** flare outwardly through a fillet F into the platform **64** and form the surface that is the gaspath surface **64***a* of the platform **64**. The platform includes additional platform fiber plies **76** that extend adjacent the skin fiber plies **70** and make up the radial thickness of the platform **64**. With respect to proximity to the gaspath side **64***a* of the platform ("first" being closest in proximity, followed by "second"), the platform plies **76** include a first platform ply **76***a*, a second platform ply **76***b*, and at least one intermediate platform ply **76***c* (two shown) between the first and second plies **76**/**76***b*.
(23) The sides **62***c*/**62***d* of the airfoil section **62**, the fillet F, and the platform **64** may require cooling. In that regard, the airfoil **60** includes at least one cooling passage **78** (shown schematically in FIG. **2**) for a flow of cooling air. For example, the cooling air is bleed air from the compressor section **24** that is provided into the internal cavity **61** and flows from the internal cavity **61** into the cooling passage(s) **78**.
(24) FIG. **4** illustrates the airfoil **60** with the skin fiber plies **70** removed so that the passage **78** is visible. In general, in this example, the passage **78** extends radially in the airfoil section **62** from a mid-span region along the suction side wall **62***d* and then under the fillet F and into the platform **64** near the leading edge **62***a*. The passage **78** has several sections, including at least one inlet orifice **78***a*, an airfoil passage section **78***b*, at least one outlet orifice **78***c* (FIGS. **2**, **3**A), and a platform passage section **78***d*. Examples of each of these sections are discussed in further detail as follows.
(25) The inlet orifice **78***a* opens through the innermost core fiber ply **68***a* to the internal cavity **61**. In the illustrated example, there is one inlet orifice **78***a*, and the inlet orifice **78***a* also extends through at least one of the intermediate core fiber plies **68***c* (the one contiguous with the innermost core fiber ply **68***a*). There could alternatively be more than one inlet orifice **78***a*, such as two, three, or more than five. The inlet orifice **78***a* in one example has a centerline that is substantially perpendicular to the localized face of the innermost core fiber ply **68***a* in the internal cavity **61**. Such an orientation may be considered to be a "neutral" orientation with regard to incoming cooling air flow. In one alternative example, the inlet orifice **78***a* is sloped, such as in a radial direction, to facilitate control of flow of the cooling air into the passage **78**. A sloped orientation may be considered to be a "non-neutral" orientation that either increases or decreases flow into the passage **78**, in comparison to the neutral orientation.
(26) The airfoil passage section **78***b* initiates at the inlet orifice **78***a* and extends radially along one or more of the intermediate core fiber plies **68***c* to the platform **64**. In the example shown, the airfoil passage section **78***b* is of uniform cross-section along its full length and is sloped to have the lower (radially inward) portion forward of the upper (radially outward) portion. The path of the airfoil passage section **78***b*, however, can be selected to coincide with a particularly hot portion of the airfoil section **62** or leading edge **62***a* and, in that regard, may be located either farther forward or farther aft than depicted, and the radial length may be lengthened or shortened from that shown.
(27) Where "inner" and "outer" denote relative proximity to the internal cavity **61** ("inner" being closest to the cavity **61**, followed by "outer"), the airfoil passage section **78***b* is bound (see FIG. **4**), on an inner side (S.sub.Inner) by one of the intermediate core fiber plies **68***c* (the one contiguous with the innermost core fiber ply **68***a*), is bound on lateral sides (S.sub.Lat1 and S.sub.Lat2) by the next consecutive one of the intermediate core fiber plies **68***c* and the outermost core fiber ply **68***b*, and is bound on an outer side by one of the skin fiber plies **70** (the one contiguous with the

outermost core fiber ply **68***b*), which is excluded in FIG. **4** but extends across the airfoil passage section **78***b* shown. The airfoil passage section **78***b* thus has a height (in the through-wall direction of the airfoil section **62**) of two fiber plies and is relatively close (three fiber ply thicknesses) to the exterior surface to provide cooling to the airfoil section **62**.

(28) The platform passage section **78***d*, portions of which are also depicted in FIG. **5** (excluding two of the skin fiber plies) and FIG. **6** (sectioned), extends along the platform fiber plies **76** and connects the airfoil passage section **78***b* to the outlet orifice or orifices **78***c*. Where "first" and "second" designate proximity to the gaspath side **64***a* of the platform **64** ("first" being closest in proximity, followed by "second"), the platform passage section **78***d* is bound on a first platform passage side (S**1**) by one (the middle one) of the skin fiber plies **70**, is bound on lateral sides (L**1** and L**2**) by the first platform fiber ply **76***a* and another one of the skin fiber plies **70** (the one that is contiguous with the first platform fiber ply **76***a*), and is bound on a second platform passage side (S**2**) by one of the intermediate platform fiber plies **76***c* (the one contiguous with the first platform fiber ply **76***a*). The platform passage section **78***d* thus has a height (radially) of two fiber plies and is relatively close (two fiber ply thicknesses) to the gaspath side **64***a* of the platform to provide cooling to the platform **64**.

(29) As best shown in FIG. **4**, the platform passage section **78***d* has first leg **80***a* and a second leg **80***b* that meet at an elbow **80***c*. The first leg **80***a* extends away from the airfoil section **62**, and the second leg **80***b* curves around the leading edge **62***a* of the airfoil section **62**. The region of the leading edge **62***a* and fillet F may be under considerable stress. Such stresses in a CMC part may tend to cause delamination between fiber plies. In this regard, the proposition of using a passage close to the leading edge **62***a* or fillet F is generally undesirable, as it may cause a discontinuity in the ceramic fibers and thereby potentially weaken the CMC material in that area. Rather, the first leg **80***a* of the platform passage section **78***d* serves to displace the second leg **80***b* and outlet orifices **78***c* a distance from the leading edge **62***a* and fillet F, so as to circumvent placement of a discontinuity near to those regions.

(30) The outlet orifice or orifices **78***c* (FIG. **6**) open through the skin fiber plies **70**. For example, the orifice **78***c* extends through two of the skin fiber plies **70** (the first two, from the gaspath side **64***a*). In the overall cooling circuit, the cooling air enters the inlet orifice or orifices **78***a*, flows down the airfoil passage section **78***b*, then into the platform passage section **78***d*, and then out through the outlet orifice or orifices **78***c* into the core flow path C. The cross-sectional sizes of the orifice **78***a*, airfoil passage section **78***b*, platform passage section **78***d*, and outlet orifice **78***c* may be selected to provide a desired flow of cooling air and thus a desired level of cooling.

(31) FIG. **7** illustrates another example of an airfoil **160** that is the same as the airfoil **60**, except that the airfoil **160** further includes at least one bypass inlet orifice **178***e* in the platform **64**. The bypass inlet orifice opens to the platform passage section **78***d* and connects the internal cavity **61** with the platform passage section **78***d*, to bypass flow through the airfoil passage section **78***b*. The bypass inlet orifice **178***e* thus serves to provide additional cooling air flow into the platform passage section **78***d*.

(32) FIG. **8** illustrates a radial (inward) view of another example of an airfoil **260** that is the same as the airfoil **60**, except that the airfoil **260** includes an additional cooling passage **278**. The (first) cooling passage **78** extends through the suction side wall **62***c* and the second cooling passage **278** extend through the pressure side wall **62***d*. In this case, the outlet orifices **78***c* and a portion of the platform passage section **78***d* under the outlet orifices **78***c* is common to both cooling passages **78**/**278**. As also shown in this example, the cooling passages **78**/**278** are symmetric to each other about a line of symmetry A**1**, which may be an axial or chordal line. As an example, such symmetry may facilitate uniform cooling of the airfoil **260**, although in other examples the passages **78**/**278** may be non-symmetric to meet other cooling requirements.

(33) FIG. **9** depicts a method for fabricating an airfoil according to the examples herein. Although not limited, the depicted example is based upon a ply lay-up process on which the various fiber

plies **66** and filler elements **74** are laid-up to form a preform. For example, the fiber plies **66** initially contain no matrix. The core fiber plies **68** are provided with through-slots **82**, which may be formed by laser cutting or other suitable technique that does not substantially damage the fibers or result in undesirably uneven cut lines. The core fiber plies **68** are laid-up on a mandrel or other support surface such that the through-slots **82** align to form the airfoil passage section **78***b* of the passage **78**. The filler elements **74** are positioned adjacent the core fiber plies **68**. The skin fiber plies **70** are then wrapped around the core fiber plies **68** and the filler elements **74**, and the platform fiber plies **76** are laid-up adjacent to the flared portion of the skin fiber plies **70** to form the platform **64**. The platform fiber ply **76***a* and the flared portion of the inner skin fiber ply **70** includes through-slots **84** that align to form the platform passage section **78***d*. The preform is then densified with the ceramic matrix to form the CMC **65**. For example, the ceramic matrix is formed by, but not limited to, chemical vapor infiltration (CVI), melt infiltration (MI), a hybrid of CVI and MI, and/or polymer infiltration and pyrolysis (PIP). The inlet orifice **78***a* and outlet orifices **78***c* may be formed after densification, such as by one or more drilling operations or be cut into the plies prior to layup.

(34) The disclosed methodology enables a substantial portion of the passage **78** to be formed prior to densification. This not only eliminates a need for machining the passages into the final CMC but also enables enhanced densification of the CMC. For instance, densification depends to some extent on the ability of the matrix material or matrix precursor material (i.e., infiltrants) to flow into all depths of the preform during the densification process so that the preform becomes fully densified. In some cases, however, the thickness of the preform can exceed a depth at which the infiltrants can readily flow under practical processing conditions and times and achieve the desired density. As a result, the preform may be only partially densified in some regions, with pores or voids in the regions that the infiltrant cannot reach. The through-slots **82**/**84** provide additional flow paths for the matrix material or matrix precursor material during densification and thereby can enhance densification in regions that may otherwise not be fully densified.

(35) Although a combination of features is shown in the illustrated examples, not all of them need to be combined to realize the benefits of various embodiments of this disclosure. In other words, a system designed according to an embodiment of this disclosure will not necessarily include all of the features shown in any one of the Figures or all of the portions schematically shown in the Figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

(36) The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from this disclosure. The scope of legal protection given to this disclosure can only be determined by studying the following claims.

Claims

1. An airfoil comprising: a platform having a core gaspath side and an opposite, non-core-gaspath side; and an airfoil section extending from the core gaspath side of the platform, the airfoil section and the platform being formed of a ceramic matrix composite including: core fiber plies defining a radial tube that circumscribes an internal cavity in the airfoil section, the core fiber plies including, relative to the internal cavity, an innermost core fiber ply, an outermost core fiber ply, and at least one intermediate core fiber ply between the innermost core fiber ply and the outermost core fiber ply, skin fiber plies defining an exterior of the airfoil section, the skin fiber plies wrapping around the core fiber plies and flaring outwardly through a fillet into the platform, platform fiber plies extending in the platform adjacent the skin fiber plies; and at least one cooling passage including: at least one inlet orifice opening through the innermost core fiber ply to the internal cavity, an airfoil passage section extending along the at least one intermediate core fiber ply from the at least

one inlet orifice to the platform, the airfoil passage section bound, relative to the internal cavity, on an inner side and on lateral sides by the at least one intermediate core fiber ply, and is bound on an outer side by one of the skin fiber plies at least one outlet orifice in the platform opening through the skin fiber plies to the core gaspath side, and a platform passage section extending along the platform fiber plies and connecting the airfoil passage section to the at least one outlet orifice.
2. The gas turbine engine as recited in claim 1, wherein the at least one inlet orifice extends through at least one of the intermediate core fiber plies.
3. The gas turbine engine as recited in claim 1, wherein, with respect to radial proximity to the gaspath side, the platform fiber plies include first and second platform fiber plies, and at least one intermediate platform fiber ply between the first and second platform fiber plies, and the platform passage section is bound on a first platform passage side by one of the skin fiber plies, is bound on lateral sides by another of the skin fiber plies and by the first platform fiber ply, and is bound on a second platform passage side by one of the intermediate platform fiber plies.
4. The gas turbine engine as recited in claim 3, wherein in the platform passage section includes a first leg that extends away from the airfoil section, and a second leg that curves around a leading edge of the airfoil section.
5. The gas turbine engine as recited in claim 1, wherein the airfoil passage section is bound on an inner side and on lateral sides by the at least one intermediate core fiber ply and is bound on an outer side by one of the skin fiber plies, the at least one inlet orifice extends through at least one of the intermediate core fiber plies, with respect to radial proximity to the gaspath side, the platform fiber plies include first and second platform fiber plies, and at least one intermediate platform fiber ply between the first and second platform fiber plies, and the platform passage section is bound on a first platform passage side by one of the at least one intermediate platform fiber plies, is bound on lateral sides by the first platform fiber ply and by the at least one intermediate platform fiber ply, and is bound on a second platform passage side by one of the skin fiber plies.
6. The gas turbine engine as recited in claim 1, further comprising a bypass inlet orifice in the platform, the bypass inlet orifice opening to the platform passage section and connecting the internal cavity with the platform passage section to bypass flow through the airfoil passage section.
7. The gas turbine engine as recited in claim 1, where the at least one cooling passage includes first and second cooling passages extending through, respectively, a suction side wall and a pressure side wall of the airfoil section.
8. The gas turbine engine as recited in claim 7, where the first and second cooling passages are symmetric to each other.
9. A gas turbine engine comprising: a compressor section; a combustor in fluid communication with the compressor section; and a turbine section in fluid communication with the combustor, the turbine section having an airfoil comprising: a platform having a core gaspath side and an opposite, non-core-gaspath side; an airfoil section extending from the core gaspath side of the platform, the airfoil section and the platform being formed of a ceramic matrix composite including: core fiber plies defining a radial tube that circumscribes an internal cavity in the airfoil section, the core fiber plies including, relative to the internal cavity, an innermost core fiber ply, an outermost core fiber ply, and at least one intermediate core fiber ply between the innermost core fiber ply and the outermost core fiber ply, skin fiber plies defining an exterior of the airfoil section, the skin fiber plies wrapping around the core fiber plies and flaring outwardly through a fillet into the platform, platform fiber plies extending in the platform adjacent the skin fiber plies; and at least one cooling passage including: at least one inlet orifice opening through the innermost core fiber ply to the internal cavity, an airfoil passage section extending along the at least one intermediate core fiber ply from the at least one inlet orifice to the platform, at least one outlet orifice in the platform opening through the skin fiber plies to the core gaspath side, and a platform passage section extending along the platform fiber plies and connecting the airfoil passage section to the at least one outlet orifice, wherein, with respect to radial proximity to the gaspath side, the platform fiber

plies include first and second platform fiber plies, and at least one intermediate platform fiber ply between the first and second platform fiber plies, and the platform passage section is bound on a first platform passage side by one of the skin fiber plies, is bound on lateral sides by another of the skin fiber plies and by the first platform fiber ply, and is bound on a second platform passage side by one of the intermediate platform fiber plies.

10. An airfoil comprising: a platform having a core gaspath side and an opposite, non-core-gaspath side; and an airfoil section extending from the core gaspath side of the platform, the airfoil section and the platform being formed of a ceramic matrix composite including: core fiber plies defining a radial tube that circumscribes an internal cavity in the airfoil section, the core fiber plies including, relative to the internal cavity, an innermost core fiber ply, an outermost core fiber ply, and at least one intermediate core fiber ply between the innermost core fiber ply and the outermost core fiber ply, skin fiber plies defining an exterior of the airfoil section, the skin fiber plies wrapping around the core fiber plies and flaring outwardly through a fillet into the platform, platform fiber plies extending in the platform adjacent the skin fiber plies; and at least one cooling passage including: at least one inlet orifice opening through the innermost core fiber ply to the internal cavity, an airfoil passage section extending along the at least one intermediate core fiber ply from the at least one inlet orifice to the platform, at least one outlet orifice in the platform opening through the skin fiber plies to the core gaspath side, and a platform passage section extending along the platform fiber plies and connecting the airfoil passage section to the at least one outlet orifice, wherein the at least one cooling passage includes first and second cooling passages extending through, respectively, a suction side wall and a pressure side wall of the airfoil section, and the first and second cooling passages are symmetric to each other.