Claims

1. An electroformed sheath for protecting an airfoil of a gas turbine engine, comprising:

a sheath body having a leading edge;

a pressure side wall and an opposed suction side wall of the sheath body, which side walls meet at the leading edge and extend away from the leading edge to define a cavity between the side walls;

a head section of the sheath body between the leading edge and the cavity; and

a mandrel insert positioned between the pressure side wall and suction side wall;

wherein the mandrel insert includes a cross-sectional geometry that is generally wedge-shaped, and

wherein the mandrel insert is made of a non-metallic composite;

wherein the mandrel insert is coated with a metallic material;

wherein the mandrel insert is defined by a length and a width, and

wherein the width of the mandrel insert is greater than a thickness of the sheath body pressure side wall or a thickness of the sheath body suction side wall.

2. The electroformed sheath of claim 1, wherein the head section is defined by a length and a width, and wherein a ratio of the length to the width is related to a radius defined by the leading edge.

3. The electroformed sheath of claim 1, wherein the non-metallic composite includes one or more of the following materials: fiber-reinforced thermoset composite, fiber-reinforced thermoplastic composite, continuous or discontinuous carbon fiber or fiberglass fiber, bismaleimide, polyimide families, or thermoplastic matrix resins.

4. The electroformed sheath of claim 1, wherein the mandrel insert is a honeycomb-like structure.

5. The electroformed sheath of claim 1, wherein the metallic material includes one or more of the following materials: graphite, aluminum, silver or palladium.

6. The electroformed sheath of claim 1, wherein a dimension of the mandrel insert is selected in order to achieve a dimension of the sheath body.

7. The electroformed sheath of claim 1, wherein a geometry of the mandrel insert is selected in order to achieve a geometry of the sheath body.

8. The electroformed sheath of claim 1, wherein sheath body is made of a material that is capable of being electroplated.

9. The electroformed sheath of claim 1, wherein the sheath body is made of one or more of the following materials: nickel, nickel-cobalt alloy.

10. A method for protecting an airfoil of a gas turbine engine, the method comprising the steps of:

securing an electrically conductive mandrel insert to a mandrel, wherein the mandrel insert includes a cross-sectional geometry that is generally wedge-shaped;

electroplating, in an electroplate bath, a sheath body onto the mandrel and the mandrel insert;

removing the mandrel from the sheath body so that a sheath cavity is defined within the sheath body by the position occupied by the mandrel to form an electroformed sheath, wherein the sheath body includes a pressure side wall and an opposed suction side wall; and

securing the airfoil within the sheath cavity so that the electroformed sheath protects the airfoil,

wherein the mandrel insert is made of a non-metallic composite;

wherein the mandrel insert is coated with a metallic material;

wherein the mandrel insert is defined by a length and a width, and

wherein the width of the mandrel insert is greater than a thickness of the sheath body pressure side wall or a thickness of the sheath body suction side wall.

11. An airfoil of a gas turbine engine, comprising:

a sheath body having a leading edge;

a pressure side wall and an opposed suction side wall of the sheath body, which side walls meet at the leading edge and extend away from the leading edge to define a cavity between the side walls;

a head section of the sheath body between the leading edge and the cavity; and

a mandrel insert positioned between the pressure side wall and suction side wall;

wherein the airfoil fills the cavity in affixing the electroformed sheath to the airfoil so that the leading edge, the head section and the mandrel insert protect the airfoil;

wherein the mandrel insert includes a cross-sectional geometry that is generally wedge-shaped,

wherein the mandrel insert is made of a non-metallic composite;

wherein the mandrel insert is coated with a metallic material;

wherein the mandrel insert is defined by a length and a width, and

wherein the width of the mandrel insert is greater than a thickness of the sheath body pressure side wall or a thickness of the sheath body suction side wall.

12. The airfoil of claim 11, wherein the airfoil is made of a material that is less durable than the non-metallic composite.

13. The airfoil of claim 12, wherein the airfoil is one of the following: a fan blade, a turbine blade, or a compressor blade.

Claims

1. An electroformed sheath for protecting an airfoil of a gas turbine engine, comprising:

a sheath body having a leading edge;

a pressure side wall and an opposed suction side wall of the sheath body, which side walls meet at the leading edge and extend away from the leading edge to define a cavity between the side walls;

a head section of the sheath body between the leading edge and the cavity; and

a mandrel insert positioned between the pressure side wall and suction side wall;

wherein the mandrel insert includes a cross-sectional geometry that is generally wedge-shaped, and

wherein the mandrel insert is made of a non-metallic composite;

wherein the mandrel insert is coated with a metallic material;

wherein the mandrel insert is defined by a length and a width, and

wherein at a given axial location along the length of the mandrel insert the width of the mandrel insert is greater than a thickness of the sheath body pressure side wall or a thickness of the sheath body suction side wall.

2. The electroformed sheath of claim 1, wherein the head section is defined by a length and a width, and wherein a ratio of the length to the width is related to a radius defined by the leading edge.

3. The electroformed sheath of claim 1, wherein the non-metallic composite includes one or more of the following materials: fiber-reinforced thermoset composite, fiber-reinforced thermoplastic composite, continuous or discontinuous carbon fiber or fiberglass fiber, bismaleimide, polyimide families, or thermoplastic matrix resins.

4. The electroformed sheath of claim 1, wherein the mandrel insert is a honeycomb-like structure.

5. The electroformed sheath of claim 1, wherein the metallic material includes one or more of the following materials: graphite, aluminum, silver or palladium.

6. The electroformed sheath of claim 1, wherein a dimension of the mandrel insert is selected in order to achieve a dimension of the sheath body.

7. The electroformed sheath of claim 1, wherein a geometry of the mandrel insert is selected in order to achieve a geometry of the sheath body.

8. The electroformed sheath of claim 1, wherein sheath body is made of a material that is capable of being electroplated.

9. The electroformed sheath of claim 1, wherein the sheath body is made of one or more of the following materials: nickel, nickel-cobalt alloy.

10. A method for protecting an airfoil of a gas turbine engine, the method comprising the steps of:

securing an electrically conductive mandrel insert to a mandrel, wherein the mandrel insert includes a cross-sectional geometry that is generally wedge-shaped;

electroplating, in an electroplate bath, a sheath body onto the mandrel and the mandrel insert;

removing the mandrel from the sheath body so that a sheath cavity is defined within the sheath body by the position occupied by the mandrel to form an electroformed sheath, wherein the sheath body includes a pressure side wall and an opposed suction side wall; and

securing the airfoil within the sheath cavity so that the electroformed sheath protects the airfoil,

wherein the mandrel insert is made of a non-metallic composite;

wherein the mandrel insert is coated with a metallic material;

wherein the mandrel insert is defined by a length and a width, and

wherein at a given axial location along the length of the mandrel insert the width of the mandrel insert is greater than a thickness of the sheath body pressure side wall or a thickness of the sheath body suction side wall.

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a sheath body having a leading edge;

a pressure side wall and an opposed suction side wall of the sheath body, which side walls meet at the leading edge and extend away from the leading edge to define a cavity between the side walls;

a head section of the sheath body between the leading edge and the cavity; and

a mandrel insert positioned between the pressure side wall and suction side wall;

wherein the airfoil fills the cavity in affixing the electroformed sheath to the airfoil so that the leading edge, the head section and the mandrel insert protect the airfoil;

wherein the mandrel insert includes a cross-sectional geometry that is generally wedge-shaped,

wherein the mandrel insert is made of a non-metallic composite;

wherein the mandrel insert is coated with a metallic material;

wherein the mandrel insert is defined by a length and a width, and

wherein at a given axial location along the length of the mandrel insert the width of the mandrel insert is greater than a thickness of the sheath body pressure side wall or a thickness of the sheath body suction side wall.

12. The airfoil of claim 11, wherein the airfoil is made of a material that is less durable than the non-metallic composite.

13. The airfoil of claim 12, wherein the airfoil is one of the following: a fan blade, a turbine blade, or a compressor blade.