IDENTIFIABLE COMPOSITE REWORK SYSTEM AND METHOD

TECHNOLOGICAL FIELD

The present disclosure relates generally to the field of composite rework and composite rework materials, systems, and methods. More specifically the present disclosure relates to the field of detecting regions of composite rework, and detectable composite rework materials, systems, and methods.

BACKGROUND

As the use of composite materials in manufacturing continues, there exists a continuing need to rework such materials. For various composite material products, repeated rework of a composite material section may not desired, or may not be allowed by regulation. Determining the existence and location of a previously reworked section is desirable.

SUMMARY

Aspects of the present disclosure are directed to a doped composite rework material including a fiber-containing material, a resin-containing material, and a dopant, with the dopant configured to impart ~~an~~ a detectable identifying characteristic to an entirety of a ~~the~~ composite rework material to form ~~a~~ the doped composite rework material. The identifying characteristic includes a characteristic that can be detected visually.

In another aspect, the identifying characteristic is detectable by a detector.

In a further aspect, the identifying characteristic is a visual characteristic that is detected visually.

Further disclosed aspects are directed to objects comprising a substrate, with the substrate including a composite material, with the composite material including a composite rework material region. The composite rework material region includes the doped composite rework material as described.

Further disclosed aspects are directed to objects, including structural objects such as, for example, buildings, bridges, etc., with such objects including a composite rework material including a fiber-containing material, a resin-containing material, and a dopant, with the dopant configured to impart an identifying characteristic to the composite rework material.

According to another disclosed aspect, vehicles include a composite rework material including a fiber-containing material, a resin-containing material, and a dopant, said dopant configured to impart an identifying characteristic to the composite rework material. Such vehicles include, for example, a manned spacecraft, an unmanned spacecraft, a manned

rotorcraft, an unmanned rotorcraft, a drone, a satellite, a manned terrestrial vehicle, an unmanned terrestrial vehicle; a manned surface marine vehicle, an unmanned surface marine vehicle, a manned sub-surface marine vehicle, an unmanned sub-surface marine vehicle, etc., and combinations thereof.

Further aspects of the present disclosure provide methods for preluding reworking a reworked composite substrate material. The method includes applying a doped composite rework material to a composite substrate material to form a doped composite rework material region, with the doped composite rework material including a fiber-containing material, a resin-containing material, and a dopant. The dopant is configured to impart a detectable identifying characteristic to an entirety of a composite rework material to form the doped composite rework material. The identifying characteristic includes a characteristic that can be detected visually.

In a further aspect, presently disclosed methods include curing the doped composite material.

According to a present aspect, methods for detecting a previously reworked composite material region on a composite substrate and methods for precluding reworking a previously reworked composite substrate material region on a composite substrate are disclosed. One presently disclosed method includes applying a doped composite material to a composite substrate material to form a doped composite rework material applied to a composite substrate to form a doped composite material rework region on the composite substrate, with the doped composite rework material including a fiber-containing material, a resin-containing material, and a dopant.

In a further aspect, presently disclosed methods include curing the doped composite material.

According to another aspect, a method for detecting a composite material rework region on a substrate is disclosed, with the method including removing a coating from a composite substrate material to form an exposed composite material rework region, detecting a doped composite material rework region, said composite material rework region comprising a doped composite rework material, and identifying at least one identifying characteristic of the doped composite rework material.

According to a further aspect, disclosed methods further include providing a catalyst to the composite material rework region, and activating the doped composite repair material.

According to a further aspect, the identifying characteristic includes a visual characteristic that is visibly or visually detected.

CLAIMS

1. A doped composite rework material comprising;

a fiber-containing material;

a resin-containing material; and

a dopant, said dopant configured to impart ~~an~~ a detectable identifying characteristic to an entirety of a composite rework material to form ~~a~~ the doped composite rework material,

wherein the identifying characteristic includes a characteristic that can be detected visually.

~~2. The doped composite rework material Claim 1, wherein the doped composite rework material (26) comprises a visual identifying characteristic or a non-visual identifying characteristic.~~

~~3~~2. The doped composite rework material of Claim~~s~~ 1 ~~or 2~~, wherein the doped composite rework material comprises at least one of: a pigment dopant; a UV-absorbing dopant; a photo-sensitive dopant; an IR-absorbing dopant; and combinations thereof.

~~4. The doped composite rework material of any one of Claims 1-3, wherein the doped composite rework material comprises a magnetic dopant or a radioactive dopant.~~

~~5~~3. The doped composite rework material of ~~any one of~~ Claims 1~~-4~~ or 2, wherein the fiber-containing material comprises at least one of:

a glass fiber, a carbon fiber, a boron fiber, an aramid fiber, or combinations thereof.

~~6~~4. The doped composite rework material of any one of Claims 1-~~5~~3, wherein the resin-containing material comprises: an epoxy-based resin or an acrylamide-based resin.

~~7~~5. A substrate comprising a composite material, said composite material comprising a composite rework material region, said composite rework material region comprising the doped composite rework material of any one of Claims 1-~~6~~4.

~~8~~6. An object comprising the substrate of Claim ~~7~~5, wherein the object is a vehicle selected from the group consisting of:

a manned aircraft, an unmanned aircraft, a manned spacecraft, an unmanned spacecraft, a rotorcraft, an unmanned rotorcraft, a drone, a satellite, a manned terrestrial vehicle, an unmanned terrestrial vehicle; a manned surface marine vehicle, an unmanned surface marine vehicle, a manned sub-surface marine vehicle, an unmanned sub-surface marine vehicle, and combinations thereof.

~~9~~7. A method for precluding reworking a reworked composite substrate material, the method comprising:

applying a doped composite rework material to a composite substrate material to form a doped composite rework material region, the doped composite rework material comprising:

a fiber-containing material;

a resin-containing material; and

a dopant, said dopant configured to impart a detectable identifying characteristic to an entirety of a composite rework material to form the doped composite rework material,

wherein the identifying characteristic includes a characteristic that can be detected visually.

~~10~~8. The method of Claim ~~9~~7, further comprising:

curing the doped composite rework material.

~~11. The method of Claims 9 or 10, the doped composite rework material comprising a visual identifying characteristic or a non-visual identifying characteristic.~~

~~12~~9. The method of ~~any one of~~ Claim~~s 9-11~~7 or 8, the doped composite rework material comprising at least one of: a pigment dopant; a UV-absorbing dopant; a photo-sensitive dopant; an IR-absorbing dopant; and combinations thereof.

~~13. The method of any one of Claims 9-12, the doped composite rework material comprising a magnetic dopant or a radioactive dopant.~~

~~14~~10. The method of any one of Claim ~~9-13~~7-9, the fiber-containing material comprising:

_____at least one of: a glass fiber, a carbon, fiber, a boron fiber, or an aramid fiber.

~~15~~11. The method of any one of Claims ~~9-14~~7-10, the resin-containing material comprising:

_____an epoxy-based resin or an acrylamide-based resin.