BRIEF DESCRIPTION

In one aspect, a method of bonding composite structures is provided. The method includes positioning a second structure at a bonding site on a first structure and coupling a first vacuum bag to the first structure such that the first vacuum bag covers the bonding site. The method also includes applying a vacuum to the first vacuum bag to induce a first mechanical force to the second structure via the first vacuum bag. A second vacuum bag is coupled to the first structure and to the first vacuum bag such that the second vacuum bag covers the second structure and at least a portion of the first vacuum bag to define a second volume between the second vacuum bag, the first structure, and the first vacuum bag, wherein a centermost point of the second vacuum bag is capable of contacting the first vacuum bag. The method further includes applying a vacuum to the second vacuum bag to induce a second mechanical force to the second structure and to the first vacuum bag via the second vacuum bag, at least partially venting the first vacuum bag to remove at least a portion of the first mechanical force on the second structure, and maintaining the vacuum of the second vacuum bag after the at least partially venting of the first vacuum bag to maintain the second mechanical force on the second structure to bond the first structure to the second structure.

In another aspect, a composite structure bonding system is provided. The composite structure bonding system includes a first structure including a bonding site and a second structure configured to couple to the first structure at the bonding site. The composite structure bonding system also includes a first vacuum bag coupled to the first structure. The first vacuum bag is configured to apply a first mechanical force to the second structure when a vacuum is applied to the first vacuum bag. The composite structure bonding system further includes a second vacuum bag coupled to both the first structure and the first vacuum bag such that the second vacuum bag covers the second structure. A second volume is defined between the second vacuum bag, the first structure, and the first vacuum bag. A centermost point of the second vacuum bag is capable of contacting the first vacuum bag such that the second vacuum bag is configured to apply a second mechanical force to the second structure and to the first vacuum bag when a vacuum is applied to the second vacuum bag. The second vacuum bag is configured to maintain the second mechanical force on the second structure and the first vacuum bag after the first vacuum bag is at least partially vented to the atmosphere.

The features, functions, and advantages that have been discussed can be achieved independently in various embodiments or may be combined in yet other embodiments further details of which can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of an exemplary composite structure bonding system illustrating a first structure, a second structure, and a first vacuum bag;

FIG. 2 is a top view of the composite structure bonding system shown in FIG. 1 further illustrating a second vacuum bag;

WHAT IS CLAIMED IS:

1. A method of bonding composite structures, said method comprising:

positioning a second structure at a bonding site on a first structure;

coupling a first vacuum bag to the first structure such that the first vacuum bag covers the bonding site;

applying a vacuum to the first vacuum bag to induce a first mechanical force to the second structure via the first vacuum bag;

coupling a second vacuum bag to the first structure and to the first vacuum bag such that the second vacuum bag covers the second structure and at least a portion of the first vacuum bag to define a second volume between the second vacuum bag, the first structure, and the first vacuum bag, wherein a centermost point of the second vacuum bag is capable of contacting the first vacuum bag; and

applying a vacuum to the second vacuum bag to induce apply a second mechanical force to the second structure and to the first vacuum bag via the second vacuum bag;

at least partially venting the first vacuum bag to remove at least a portion of the first mechanical force on the second structure; and

maintaining the vacuum of the second vacuum bag after the at least partially venting of the first vacuum bag to maintain the second mechanical force on the second structure to bond the first structure to the second structure.

2. The method of claim 1, wherein the at least partially venting of the first vacuum bag comprises at least partially venting the first vacuum bag after applying the vacuum to the second vacuum bag.

3. The method of claim 1, wherein the at least partially venting of the first vacuum bag comprises exposing the second structure to atmospheric pressure.

4. The method of claim 1, wherein maintaining the vacuum on the second vacuum bag to maintain the second mechanical force comprises maintaining the vacuum on the second vacuum bag to maintain a compaction force on the first vacuum bag and on the second structure, and wherein the at least partially venting of the first vacuum bag comprises exposing the second structure to atmospheric pressure

to facilitate removing a plurality of volatile organic compounds from the second structure.

5. The method of claim 1, wherein the coupling the first vacuum bag to the first structure comprises sealing the first vacuum bag to the first structure with a first sealing mechanism, and wherein the coupling the second vacuum bag to the first structure comprises sealing the second vacuum bag to the first structure with a second sealing mechanism.

6. The method of claim 1, wherein the coupling the second vacuum bag to cover at least the portion of the first vacuum bag comprises coupling the second vacuum bag to the first vacuum bag such that a first probe on the first vacuum bag is uncovered by the second vacuum bag.

7. The method of claim 1, further comprising positioning a heating blanket between the first vacuum bag and the second structure.

8. The method of claim 1, wherein applying the vacuum to the second vacuum bag comprises applying the vacuum to the second vacuum bag outside an autoclave.

9. A composite structure bonding system comprising:

a first structure comprising a bonding site;

a second structure configured to couple to said first structure at said bonding site;

a first vacuum bag coupled to said first structure, wherein said first vacuum bag is configured to apply a first mechanical force to said second structure when a vacuum is applied to first vacuum bag; and

a second vacuum bag coupled to both said first structure and said first vacuum bag such that the second vacuum bag covers the second structure, wherein a second volume is defined between said second vacuum bag, said first structure, and said first vacuum bag, wherein a centermost point of said second vacuum bag is capable of contacting said first vacuum bag such that said second vacuum bag is configured to apply a second mechanical force to said second structure and to said first vacuum bag when a vacuum is applied to second vacuum bag, wherein said second vacuum bag is

configured to maintain the second mechanical force on said second structure and said first vacuum bag after said first vacuum bag is at least partially vented to the atmosphere.

10. The composite structure bonding system of claim 9, said first vacuum bag and said second vacuum bag are configured to apply the first mechanical force and the second mechanical force concurrently.

11. The composite structure bonding system of claim 9, wherein said second vacuum bag is configured to contact said first vacuum bag over an entire area of said second structure such that the second mechanical force is applied to said first vacuum bag and to the entire area of said second structure through said first bag.

12. The composite structure bonding system of claim 9, further comprising a heating blanket positioned between said first vacuum bag and said second structure.

13. The composite structure bonding system of claim 9, wherein said first vacuum bag defines a first volume between said first vacuum bag and said first structure, wherein said second structure is positioned within said first volume.

14. The composite structure bonding system of claim 13, further comprising a first probe coupled to said first vacuum bag, wherein said first probe selectively couples said first volume in flow communication with a vacuum source.

15. The composite structure bonding system of claim 14, wherein said second structure is positioned outside said second volume between said first vacuum bag and said first structure.

16. The composite structure bonding system of claim 15, wherein said first probe is positioned outside said second volume when said second vacuum bag is coupled to said first vacuum bag.

17. The composite structure bonding system of claim 15, further comprising a second probe coupled to said second vacuum bag, wherein said second probe selectively couples said second volume in flow communication with a vacuum source.

18. The composite structure bonding system of claim 9, wherein said first vacuum bag is coupled to said first structure with a first sealing mechanism, and wherein said second vacuum bag is coupled to said first structure with a second sealing mechanism.

19. The method of claim 1, wherein the first vacuum bag and the second vacuum bag are configured to apply the first mechanical force and the second mechanical force concurrently.

20. The method of claim 1, wherein the second vacuum bag is configured to contact the first vacuum bag over an entire area of the second structure such that the second mechanical force is applied to the first vacuum bag and to the entire area of the second structure through the first bag.