shaped honeycomb support was used in combination with the adhesive. The use of honeycomb-supported adhesive seams to bond acoustic honeycomb sections together is described in U.S. Patent No. 8,579,076 B2, the contents of which are hereby incorporated by reference. The honeycomb supported seams are much thinner than prior foam-type adhesive seams and can be used regardless of whether or not the protruding ends of the honeycomb are aligned along the seam. The thinner seams provided by the honeycomb-supported adhesive also minimize any interference with the acoustic properties of the spliced honeycomb. The honeycomb-supported adhesive seams are flexible so that they can be used to bond together curved honeycomb sections.

[0009] Acoustic honeycomb panels are sometimes damaged during manufacture or use. In order to repair the damaged section, it is necessary to remove the damaged portion of acoustic honeycomb and replace it with a plug of matching acoustic honeycomb that is bonded in place. Many of the same issues involved in seaming honeycomb sections together, as discussed above, are also presented when locating and bonding a plug of acoustic honeycomb in the hole formed when the damaged honeycomb has been removed. A number of other complex issues are also presented due to the fact that the acoustic honeycomb plug has to be inserted into the damaged panel rather than being bonded to an exposed edge of the acoustic honeycomb. In addition, the insertion and bonding of the acoustic honeycomb plug must be accomplished while keeping in mind that the acoustic properties of the repaired acoustic honeycomb panel should match the acoustic properties of the original non-damaged acoustic honeycomb panel.

SUMMARY OF THE INVENTION

[0009a] According to a first aspect of the present invention, there is provided a method for plugging an acoustic honeycomb panel, said method comprising the steps of:

A) providing an acoustic honeycomb panel comprising a first panel edge and a second panel edge, said acoustic honeycomb panel further comprising a plurality of panel walls that extend between said first and second panel edges, said panel walls defining a plurality of panel acoustic honeycomb cells wherein each of said panel acoustic honeycomb cells has a cross-sectional area measured perpendicular to said panel walls and a panel depth defined by the distance between the first and second panel edges, said acoustic honeycomb panel further comprising acoustic septa located within said plurality of panel acoustic

honeycomb cells, said acoustic honeycomb panel comprising a plurality of boundary walls having end portions which surround a hole extending between the first and second panel edges, said hole having a boundary defined by the end portions of said boundary walls;

B) providing an acoustic honeycomb plug comprising a first plug edge and a second plug edge, said acoustic honeycomb plug further comprising a plurality of plug walls that extend between said first and second plug edges, said plug walls defining a plurality of plug acoustic honeycomb cells wherein each of said plug acoustic honeycomb cells has a cross-sectional area measured perpendicular to said plug walls and a plug depth defined by the distance between said first and second plug edges, said acoustic honeycomb plug further comprising acoustic septa located within said plurality of plug acoustic honeycomb cells, said acoustic honeycomb plug comprising a plurality of plug perimeter walls having end portions which form a plug perimeter that is defined by said end portions of the plug perimeter walls;

C) locating said acoustic honeycomb plug within said hole so that said boundary walls and perimeter walls do not contact each other so as to form an open seam channel which is free of said boundary walls and perimeter walls, said open seam channel having a channel width defined by the distance between said plug perimeter and said hole boundary, a channel depth defined by the plug depth at said plug perimeter and the panel depth at said hole boundary and a channel circumference;

D) locating a honeycomb seam in said open seam channel to adhesively bond said acoustic honeycomb panel to said acoustic honeycomb plug, said honeycomb seam comprising:

a) a honeycomb support that is in the shape of a ribbon having a support thickness defined by the distance between a first support edge and a second support edge, a support width defined by the distance between a first support side and a second support side and a support circumference wherein the support thickness, support width and support circumference are such that said honeycomb support is located within said open seam channel, said honeycomb support comprising a plurality of support walls that extend between said first and second support edges, said support walls defining a plurality of support honeycomb cells wherein each of said support honeycomb cells has a cross-sectional area measured perpendicular to said support walls; and

b) an adhesive located in said support honeycomb cells, said adhesive being present in an amount that is sufficient to fill said open seam channel and thereby bond said plug perimeter to said panel boundary.

[0009b] According to a second aspect of the present invention, there is provided a method for repairing a damaged acoustic honeycomb panel, said repair method comprising the steps of:

A) providing an acoustic honeycomb panel comprising a first panel edge and a second panel edge, said acoustic honeycomb panel further comprising a plurality of panel walls that extend between said first and second panel edges, said panel walls defining a plurality of panel acoustic honeycomb cells wherein each of said panel acoustic honeycomb cells has a cross-sectional area measured perpendicular to said panel walls and a panel depth defined by the distance between the first and second panel edges, said acoustic honeycomb panel further comprising acoustic septa located within said plurality of panel acoustic honeycomb cells, said acoustic honeycomb panel comprising a damaged area;

B) removing said damaged area to form a plurality of boundary walls having end portions which surround a hole extending between the first and second panel edges, said hole having a boundary defined by the end portions of said boundary walls;

C) providing an acoustic honeycomb plug comprising a first plug edge and a second plug edge, said acoustic honeycomb plug further comprising a plurality of plug walls that extend between said first and second plug edges of, said plug walls defining a plurality of plug acoustic honeycomb cells wherein each of said plug acoustic honeycomb cells has a cross-sectional area measured perpendicular to said plug walls and a plug depth defined by the distance between said first and second plug edges, said acoustic honeycomb plug further comprising acoustic septa located within said plurality of plug acoustic honeycomb cells, said acoustic honeycomb plug comprising a plurality of plug perimeter walls having end portions which form a plug perimeter that is defined by said end portions of the plug perimeter walls;

D) locating said acoustic honeycomb plug within said hole so that said boundary walls and perimeter walls do not contact each other so as to form an open seam channel which is free of said boundary walls and perimeter walls, said seam channel having channel a width defined by the distance between said plug perimeter and said hole boundary, a channel depth defined by the plug depth at said plug perimeter and the panel depth at said hole boundary and a channel circumference;

E) locating a honeycomb seam in said open seam channel to adhesively bond said acoustic honeycomb panel to said acoustic honeycomb plug, said honeycomb seam comprising:

a) a honeycomb support that is in the shape of a ribbon having a support thickness defined by the distance between a first support edge and a second support edge, a support width defined by the distance between a first support side and a second support side and a support circumference wherein the support thickness, support width and support circumference are such that said honeycomb support is located within said open seam channel, said honeycomb support comprising a plurality of support walls that extend between said first and second support edges, said support walls defining a plurality of support honeycomb cells wherein each of said support honeycomb cells has a cross-sectional area measured perpendicular to said support walls; and

b) an adhesive located in said support honeycomb cells, said adhesive being present in an amount that is sufficient to fill said open seam channel and thereby bond said plug perimeter to said panel boundary.

[0009c] According to a third aspect of the present invention, there is provided a plugged acoustic honeycomb panel comprising:

A) an acoustic honeycomb panel comprising a first panel edge and a second panel edge, said acoustic honeycomb panel further comprising a plurality of panel walls that extend between said first and second panel edges, said panel walls defining a plurality of panel acoustic honeycomb cells wherein each of said panel acoustic honeycomb cells has a cross-sectional area measured perpendicular to said panel walls and a panel depth defined by the distance between the first and second panel edges, said acoustic honeycomb panel further comprising acoustic septa located within said plurality of panel acoustic honeycomb cells, said acoustic honeycomb panel comprising a plurality of boundary walls having end portions which surround a hole extending between the first and second panel edges, said hole having a boundary defined by the end portions of said boundary walls;

B) an acoustic honeycomb plug comprising a first plug edge and a second plug edge, said acoustic honeycomb plug further comprising a plurality of plug walls that extend between said first and second plug edges of, said plug walls defining a plurality of plug acoustic honeycomb cells wherein each of said plug acoustic honeycomb cells has a cross-sectional area measured perpendicular to said walls and a plug depth defined by the distance between said first and second plug edges, said acoustic honeycomb plug further comprising acoustic septa located within said plurality of plug acoustic honeycomb cells, said acoustic honeycomb plug comprising a plurality of plug perimeter walls having end portions which form a plug perimeter that is defined by said end portions of the plug perimeter walls, said acoustic honeycomb plug being located within said hole so that said boundary walls and perimeter walls do not contact each other so as to form an open seam channel which is free of said boundary walls and perimeter walls, said open seam channel having a channel width defined by the distance between said plug perimeter and said hole boundary, a channel depth defined by the plug depth at said plug perimeter and the panel depth at said hole boundary and a channel circumference; and

C) a honeycomb seam that is located in said open seam channel to adhesively bond said acoustic honeycomb panel to said acoustic honeycomb plug, said honeycomb seam comprising:

a) a honeycomb support that is in the shape of a ribbon having a support thickness defined by the distance between a first support edge and a second support edge, a support width defined by the distance between a first support side and a second support side and a support circumference wherein the support thickness, support width and support circumference are such that said honeycomb support is located within said open seam channel, said honeycomb support comprising a plurality of support walls that extend between said first and second support edges, said support walls defining a plurality of support honeycomb cells wherein each of said support honeycomb cells has a cross-sectional area measured perpendicular to said support walls; and

b) an adhesive located in said support honeycomb cells, said adhesive being present in an amount that is sufficient to fill said open seam channel and thereby bond said plug perimeter to said panel boundary.

[00010] In accordance with the present invention, it was discovered that a honeycomb supported adhesive seam may be used to bond an acoustic honeycomb plug into a hole located in an existing acoustic honeycomb. The honeycomb supported adhesive seam was found to be effective in filling the seam channel that is formed between the acoustic honeycomb plug and the acoustic honeycomb panel to provide a secure bond without adversely altering the acoustic properties of the plugged acoustic honeycomb panel.

[00011] The present invention provides a method for plugging an acoustic honeycomb panel that has a first panel edge and a second panel edge. The acoustic honeycomb panel includes a plurality of panel walls that extend between the first and second panel edges. The panel walls

What is claimed is:

1. A method for plugging an acoustic honeycomb panel, said method comprising the steps of:

A) providing an acoustic honeycomb panel comprising a first panel edge and a second panel edge, said acoustic honeycomb panel further comprising a plurality of panel walls that extend between said first and second panel edges, said panel walls defining a plurality of panel acoustic honeycomb cells wherein each of said panel acoustic honeycomb cells has a cross-sectional area measured perpendicular to said panel walls and a panel depth defined by the distance between the first and second panel edges, said acoustic honeycomb panel further comprising acoustic septa located within said plurality of panel acoustic honeycomb cells, said acoustic honeycomb panel comprising a plurality of boundary walls having end portions which surround a hole extending between the first and second panel edges, said hole having a boundary defined by the end portions of said boundary walls;

B) providing an acoustic honeycomb plug comprising a first plug edge and a second plug edge, said acoustic honeycomb plug further comprising a plurality of plug walls that extend between said first and second plug edges, said plug walls defining a plurality of plug acoustic honeycomb cells wherein each of said plug acoustic honeycomb cells has a cross-sectional area measured perpendicular to said plug walls and a plug depth defined by the distance between said first and second plug edges, said acoustic honeycomb plug further comprising acoustic septa located within said plurality of plug acoustic honeycomb cells, said acoustic honeycomb plug comprising a plurality of plug perimeter walls having end portions which form a plug perimeter that is defined by said end portions of the plug perimeter walls;

C) locating said acoustic honeycomb plug within said hole so that said boundary walls and perimeter walls do not contact each other so as to form an open seam channel which is free of said boundary walls and perimeter walls, said open seam channel having a channel width defined by the distance between said plug perimeter and said hole boundary, a channel depth defined by the plug depth at said plug perimeter and the panel depth at said hole boundary and a channel circumference;

D) locating a honeycomb seam in said open seam channel to adhesively bond said acoustic honeycomb panel to said acoustic honeycomb plug, said honeycomb seam comprising:

a) a honeycomb support that is in the shape of a ribbon having a support thickness defined by the distance between a first support edge and a second support edge, a support width defined by the distance between a first support

side and a second support side and a support circumference wherein the support thickness, support width and support circumference are such that said honeycomb support is located within said open seam channel, said honeycomb support comprising a plurality of support walls that extend between said first and second support edges, said support walls defining a plurality of support honeycomb cells wherein each of said support honeycomb cells has a cross-sectional area measured perpendicular to said support walls; and

b) an adhesive located in said support honeycomb cells, said adhesive being present in an amount that is sufficient to fill said open seam channel and thereby bond said plug perimeter to said panel boundary.

2. A method for plugging an acoustic honeycomb panel according to claim 1 wherein said honeycomb seam is located on said plug perimeter to form a seam coated acoustic honeycomb plug that is then located in said hole.

3. A method for plugging an acoustic honeycomb panel according to claim 2 wherein said adhesive is tacky when said honeycomb seam is located on said plug perimeter to form said seam coated acoustic honeycomb plug and wherein said seam coated acoustic honeycomb plug is treated so that said adhesive is not tacky when said seam coated acoustic honeycomb plug is located in said hole.

4. A method for plugging an acoustic honeycomb panel according to claim 3 wherein said seam coated acoustic honeycomb plug is treated by cooling to a temperature at which said adhesive is not tacky.

5. A method for plugging an acoustic honeycomb panel according to claim 1 wherein said honeycomb seam is a single of ribbon having a head end and a tail end wherein said head end and tail end are located next to each other.

6. A method for plugging an acoustic honeycomb panel according to claim 1 wherein said adhesive is a polyamide-imide adhesive.

7. A method for plugging an acoustic honeycomb panel according to claim 6 wherein said acoustic honeycomb panel is made from a composite material.

8. A method for plugging an acoustic honeycomb panel according to claim 1 wherein the open seam channel width is from 0.35 inch to 0.50 inch.

9. A method for plugging an acoustic honeycomb panel according to claim 1 wherein the open seam channel depth is from 0.25 inch to 3 inches.

10. A method for plugging an acoustic honeycomb panel according to claim 1 wherein the open seam channel circumference is at least 10 inches.

11. A method for plugging an acoustic honeycomb panel according to claim 1 wherein said acoustic honeycomb panel forms part of an acoustic treatment for a jet engine.

12. A method for repairing a damaged acoustic honeycomb panel, said repair method comprising the steps of:

A) providing an acoustic honeycomb panel comprising a first panel edge and a second panel edge, said acoustic honeycomb panel further comprising a plurality of panel walls that extend between said first and second panel edges, said panel walls defining a plurality of panel acoustic honeycomb cells wherein each of said panel acoustic honeycomb cells has a cross-sectional area measured perpendicular to said panel walls and a panel depth defined by the distance between the first and second panel edges, said acoustic honeycomb panel further comprising acoustic septa located within said plurality of panel acoustic honeycomb cells, said acoustic honeycomb panel comprising a damaged area;

B) removing said damaged area to form a plurality of boundary walls having end portions which surround a hole extending between the first and second panel edges, said hole having a boundary defined by the end portions of said boundary walls;

C) providing an acoustic honeycomb plug comprising a first plug edge and a second plug edge, said acoustic honeycomb plug further comprising a plurality of plug walls that extend between said first and second plug edges of, said plug walls defining a plurality of plug acoustic honeycomb cells wherein each of said plug acoustic honeycomb cells has a cross-sectional area measured perpendicular to said plug walls and a plug depth defined by the distance between said first and second plug edges, said acoustic honeycomb plug further comprising acoustic septa located within said plurality of plug acoustic honeycomb cells, said acoustic honeycomb plug comprising a plurality of plug perimeter walls having end portions which form a plug perimeter that is defined by said end portions of the plug perimeter walls;

D) locating said acoustic honeycomb plug within said hole so that said boundary walls and perimeter walls do not contact each other so as to form an open seam channel which is free of said boundary walls and perimeter walls, said seam channel having channel a width defined by the distance between said plug perimeter and said hole boundary, a channel depth defined by the plug depth at said plug perimeter and the panel depth at said hole boundary and a channel circumference;

E) locating a honeycomb seam in said open seam channel to adhesively bond said acoustic honeycomb panel to said acoustic honeycomb plug, said honeycomb seam comprising:

a) a honeycomb support that is in the shape of a ribbon having a support thickness defined by the distance between a first support edge and a second support edge, a support width defined by the distance between a first support side and a second support side and a support circumference wherein the support thickness, support width and support circumference are such that said honeycomb support is located within said open seam channel, said honeycomb support comprising a plurality of support walls that extend between said first and second support edges, said support walls defining a plurality of support honeycomb cells wherein each of said support honeycomb cells has a cross-sectional area measured perpendicular to said support walls; and

b) an adhesive located in said support honeycomb cells, said adhesive being present in an amount that is sufficient to fill said open seam channel and thereby bond said plug perimeter to said panel boundary.

13. A method for repairing a damaged acoustic honeycomb panel according to claim 10 wherein said damaged acoustic honeycomb panel forms part of an acoustic treatment for a jet engine.

14. A plugged acoustic honeycomb panel comprising:

A) an acoustic honeycomb panel comprising a first panel edge and a second panel edge, said acoustic honeycomb panel further comprising a plurality of panel walls that extend between said first and second panel edges, said panel walls defining a plurality of panel acoustic honeycomb cells wherein each of said panel acoustic honeycomb cells has a cross-sectional area measured perpendicular to said panel walls and a panel depth defined by the distance between the first and second panel edges, said acoustic honeycomb panel further comprising acoustic septa located within said plurality of panel acoustic honeycomb cells, said acoustic honeycomb panel comprising a plurality of boundary walls having end portions which surround a hole extending between the first and second panel edges, said

hole having a boundary defined by the end portions of said boundary walls;

B) an acoustic honeycomb plug comprising a first plug edge and a second plug edge, said acoustic honeycomb plug further comprising a plurality of plug walls that extend between said first and second plug edges of, said plug walls defining a plurality of plug acoustic honeycomb cells wherein each of said plug acoustic honeycomb cells has a cross-sectional area measured perpendicular to said walls and a plug depth defined by the distance between said first and second plug edges, said acoustic honeycomb plug further comprising acoustic septa located within said plurality of plug acoustic honeycomb cells, said acoustic honeycomb plug comprising a plurality of plug perimeter walls having end portions which form a plug perimeter that is defined by said end portions of the plug perimeter walls, said acoustic honeycomb plug being located within said hole so that said boundary walls and perimeter walls do not contact each other so as to form an open seam channel which is free of said boundary walls and perimeter walls, said open seam channel having a channel width defined by the distance between said plug perimeter and said hole boundary, a channel depth defined by the plug depth at said plug perimeter and the panel depth at said hole boundary and a channel circumference; and

C) a honeycomb seam that is located in said open seam channel to adhesively bond said acoustic honeycomb panel to said acoustic honeycomb plug, said honeycomb seam comprising:

a) a honeycomb support that is in the shape of a ribbon having a support thickness defined by the distance between a first support edge and a second support edge, a support width defined by the distance between a first support side and a second support side and a support circumference wherein the support thickness, support width and support circumference are such that said honeycomb support is located within said open seam channel, said honeycomb support comprising a plurality of support walls that extend between said first and second support edges, said support walls defining a plurality of support honeycomb cells wherein each of said support honeycomb cells has a cross-sectional area measured perpendicular to said support walls; and

b) an adhesive located in said support honeycomb cells, said adhesive being present in an amount that is sufficient to fill said open seam channel and thereby bond said plug perimeter to said panel boundary.

15. A plugged acoustic honeycomb panel according to claim 14 wherein said honeycomb seam is a single of ribbon having a head end and a tail end wherein said head end and tail end are located next to each other.

16. A plugged acoustic honeycomb panel according to claim 14 wherein the open seam channel width is from 0.35 inch to 0.50 inch.

17. A plugged acoustic honeycomb panel according to claim 14 wherein the open seam channel depth is from 0.25 inch to 3.0 inches.

18. A plugged acoustic honeycomb panel according to claim 14 wherein the open seam channel circumference is at least 10 inches.

19. A plugged acoustic honeycomb panel according to claim 14 wherein said acoustic honeycomb panel forms part of an acoustic treatment for a jet engine.

20. A plugged acoustic honeycomb panel according to claim 14 wherein said adhesive is a polyamide-imide adhesive.

21. A plugged acoustic honeycomb panel according to claim 20 wherein said acoustic honeycomb panel is made from a composite material.