bladder cover disposed over the plurality of inner bladders within the tool chamber to provide a barrier between the plurality of inner bladders and the part. The tool also comprises a first endcap disposed at a first end of the tool, the first endcap comprising a first endcap portion and a second endcap portion. The bladder cover comprises a flexible sheet. Each inner bladder comprises a flexible tube defining the inner bladder chamber. The first endcap portion and the second endcap portion clamp a first end of the flexible sheet therebetween. The first endcap portion and the second endcap portion clamp a first end of the flexible tube of each inner bladder therebetween to isolate the inner bladder chamber of the inner bladder within the tool chamber.

In accordance with an embodiment and any of the preceding embodiments, each of the plurality of inner bladders comprises a substantially linear tube, and wherein the plurality of inner bladders are arranged in an array within the tool chamber.

In accordance with an embodiment and any of the preceding embodiments, the tool further includes a plurality of inlet tubes, each inlet tube of the plurality of inlet tubes extending from the inner bladder chamber of a respective inner bladder to an exterior of the tool. The first endcap portion and the second endcap portion clamp the inlet tube for each inner bladder therebetween.

In accordance with an embodiment and any of the preceding embodiments, the tool further comprises a plurality of retaining elements coupled to the first endcap, wherein each retaining element of the plurality of retaining elements retains a respective inlet tube within the respective inner bladder to inhibit movement of the inlet tube with respect to the inner bladder.

In accordance with an embodiment and any of the preceding embodiments, the bladder further comprises an outer bladder enclosing the plurality of inner bladders, wherein the outer bladder comprises the bladder cover.

In accordance with an embodiment and any of the preceding embodiments, the bladder cover and the inner bladders comprise a flexible material, and the inner bladders are unitary with the bladder cover.

In accordance with an embodiment and any of the preceding embodiments, a first inner bladder of the plurality of inner bladders and a second inner bladder of the plurality of inner bladders comprise a shared wall therebetween.

In accordance with an embodiment, a bladder for a tool is disclosed. The bladder includes a plurality of inner bladders configured to be disposed within a tool chamber of the tool. Each inner bladder of the plurality of inner bladders comprises an inner bladder chamber that is independently inflatable to selectively apply pressure to a part within a tool chamber of the tool and each inner bladder comprises a flexible tube defining the inner bladder chamber. The bladder further includes a bladder cover covering the plurality of inner bladders to provide a barrier between the plurality of inner bladders and the part within the tool chamber. The bladder cover comprises a flexible sheet. A first end of the flexible sheet is configured to be clamped between a first endcap portion and a second endcap portion of a first endcap disposed at a first end of the tool. A first end of the flexible tube of each inner bladder is configured to be clamped between the first endcap portion and the second endcap portion to isolate the inner bladder chamber of the inner bladder within the tool chamber

In accordance with an embodiment and any of the preceding embodiments, each of the plurality of inner bladders comprises a substantially linear tube, and wherein the plurality of inner bladders are arranged in an array within the tool chamber.

In accordance with an embodiment and any of the preceding embodiments, the bladder cover comprises a flexible sheet, and each inner bladder comprises a flexible tube defining the inner bladder chamber.

In accordance with an embodiment and any of the preceding embodiments, the bladder further includes a plurality of inlet tubes, each inlet tube of the plurality of inlet tubes extending from the inner bladder chamber of a respective inner bladder to the exterior of the inner bladder chamber.

In accordance with an embodiment and any of the preceding embodiments, the bladder cover and the inner bladders comprise a flexible material, and the inner bladders are unitary with the bladder cover.

In accordance with an embodiment, a method of forming a part is disclosed. The method includes disposing a workpiece in a

tool chamber of a tool. The tool includes a first tool portion comprising a first tool surface. The tool further includes a second tool portion comprising a second tool surface facing the first tool surface, wherein the first tool surface and the second tool surface define the tool chamber. The method further includes disposing a bladder subassembly in the tool chamber between the first tool surface and the second tool surface. Disposing the bladder subassembly in the tool chamber comprises disposing a plurality of inner bladders within tool chamber, wherein each inner bladder of the plurality of inner bladders comprises an inner bladder

chamber, and wherein each inner bladder comprises a flexible tube defining the inner bladder chamber, disposing a bladder cover over the plurality of inner bladders within the tool chamber to provide a barrier between the plurality of inner bladders and the workpiece, wherein the bladder cover comprises a flexible sheet, disposing a first endcap at a first end of the tool, the first endcap comprising a first endcap portion and a second endcap portion, clamping a first end of the flexible sheet between the first endcap portion and the second endcap portion clamp, and clamping a first end of the flexible tube of each inner bladder between the first endcap portion and the second endcap portion to isolate the inner bladder chamber of the inner bladder within the tool chamber. The method further includes independently inflating the plurality of inner bladders to selectively apply pressure to the workpiece within the tool chamber to form the part.

In accordance with an embodiment and any of the preceding embodiments, the method further includes, before inflating the plurality of inner bladders, securing the first tool portion with respect to the second tool portion to form an airtight seal around the tool chamber.

In accordance with an embodiment and any of the preceding embodiments, inflating the plurality of inner bladders further comprises: inflating the plurality of inner bladders with a gas.

In accordance with an embodiment and any of the preceding embodiments, inflating the plurality of inner bladders further comprises: inflating the plurality of inner bladders with a liquid.

In accordance with an embodiment and any of the preceding embodiments, inflating the plurality of inner bladders further includes inflating at least two of the plurality of inner bladders to different pressures.

In accordance with an embodiment and any of the preceding embodiments, inflating the plurality of inner bladders further includes inflating at least two of the plurality of inner bladders at different times.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A-1D are perspective views of a tool for forming a part using a bladder subassembly, illustrating assembly of the tool around a workpiece, according to an embodiment;

FIGS. 2A-2C are cross-sectional views of the tool of FIGS. 1A-1D illustrating the components of the bladder subassembly and assembly of the tool around a workpiece;

FIG. 3 is a cross-sectional view of a tool having an alternative bladder subassembly including an outer bladder enclosing the plurality of inner bladders, according to another embodiment;

CLAIMS

1. A tool for forming a part, the tool comprising:

a first tool portion comprising a first tool surface;

a second tool portion comprising a second tool surface facing the first tool surface, wherein the first tool surface and the second tool surface define a tool chamber for forming the part;

a bladder subassembly disposed in the tool chamber between the first tool surface and the second tool surface, the bladder subassembly comprising:

a plurality of inner bladders disposed within the tool chamber, wherein each inner bladder of the plurality of inner bladders comprises an inner bladder chamber that is independently inflatable to selectively apply pressure to the part within the tool chamber; and

a bladder cover disposed over the plurality of inner bladders within the tool chamber to provide a barrier between the plurality of inner bladders and the part;

a first endcap disposed at a first end of the tool, the first endcap comprising a first endcap portion and a second endcap portion,

wherein the bladder cover comprises a flexible sheet,

wherein each inner bladder comprises a flexible tube defining the inner bladder chamber,

wherein the first endcap portion and the second endcap portion clamp a first end of the flexible sheet therebetween, and

wherein the first endcap portion and the second endcap portion clamp a first end of the flexible tube of each inner bladder therebetween to isolate the inner bladder chamber of the inner bladder within the tool chamber.

2. The tool of claim 1, wherein each inner bladder of the plurality of inner bladders comprises a substantially linear tube, and wherein the plurality of inner bladders are arranged in an array within the tool chamber.

3. The tool of claim 1 or 2, further comprising a plurality of inlet tubes, each inlet tube of the plurality of inlet tubes extending from the inner bladder chamber of a respective inner bladder to an exterior of the tool, and

wherein the first endcap portion and the second endcap portion clamp the inlet tube for each inner bladder therebetween.

4. The tool of claim 3, further comprising a plurality of retaining elements coupled to the first endcap, wherein each retaining element of the plurality of retaining elements retains a respective inlet tube within the respective inner bladder to inhibit movement of the inlet tube with respect to the inner bladder.

5. The tool of any one of claims 1-4, further comprising an outer bladder enclosing the plurality of inner bladders within an outer bladder chamber, wherein the outer bladder comprises the bladder cover.

6. The tool of any one of claims 1-5, wherein the bladder cover and the inner bladders comprise a flexible material, and

wherein the inner bladders are unitary with the bladder cover.

7. The tool of claim 6, wherein a first inner bladder of the plurality of inner bladders and a second inner bladder of the plurality of inner bladders comprise a shared wall therebetween.

8. A bladder for a tool comprising:

a plurality of inner bladders configured to be disposed within a tool chamber of the tool, wherein each inner bladder of the plurality of inner bladders comprises an inner bladder chamber that is independently inflatable to selectively apply pressure to a part within the tool chamber of the tool, and wherein each inner bladder comprises a flexible tube defining the inner bladder chamber; and

a bladder cover covering the plurality of inner bladders to provide a barrier between the plurality of inner bladders and the part within the tool chamber, wherein the bladder cover comprises a flexible sheet,

wherein a first end of the flexible sheet is configured to be clamped between a first endcap portion and a second endcap portion of a first endcap disposed at a first end of the tool, and

wherein a first end of the flexible tube of each inner bladder is configured to be clamped between the first endcap portion and the second endcap portion to isolate the inner bladder chamber of the inner bladder within the tool chamber.

9. The bladder of claim 8, wherein each of the plurality of inner bladders comprises a substantially linear tube, and wherein the plurality of inner bladders are arranged in an array within the tool chamber.

10. The bladder of claim 8 or 9, wherein the bladder cover comprises a flexible sheet, and

wherein each inner bladder comprises a flexible tube defining the inner bladder chamber.

11. The bladder of claim 10, further comprising a plurality of inlet tubes, each inlet tube of the plurality of inlet tubes extending from the inner bladder chamber of a respective inner bladder to an exterior of the tool.

12. The bladder of any one of claims 8-11, wherein the bladder cover and the inner bladders comprise a flexible material, and

wherein the inner bladders are unitary with the bladder cover.

13. A method of forming a part comprising:

disposing a workpiece in a tool chamber of a tool, the tool comprising:

a first tool portion comprising a first tool surface; and

a second tool portion comprising a second tool surface facing the first tool surface, wherein the first tool surface and the second tool surface define the tool chamber;

disposing a bladder subassembly in the tool chamber between the first tool surface and the second tool surface, wherein disposing the bladder subassembly in the tool chamber comprises:

disposing a plurality of inner bladders within the tool chamber, wherein each inner bladder of the plurality of inner bladders comprises an inner bladder chamber, and wherein each inner bladder comprises a flexible tube defining the inner bladder chamber;

disposing a bladder cover over the plurality of inner bladders within the tool chamber to provide a barrier between the plurality of inner bladders and the workpiece, wherein the bladder cover comprises a flexible sheet;

disposing a first endcap at a first end of the tool, the first endcap comprising a first endcap portion and a second endcap portion;

clamping a first end of the flexible sheet between the first endcap portion and the second endcap portion clamp; and

clamping a first end of the flexible tube of each inner bladder between the first endcap portion and the second endcap portion to isolate the inner bladder chamber of the inner bladder within the tool chamber; and

independently inflating the plurality of inner bladders to selectively apply pressure to the workpiece within the tool chamber to form the part.

14. The method of claim 13, further comprising:

before inflating the plurality of inner bladders, securing the first tool portion with respect to the second tool portion to form an airtight seal around the tool chamber.

15. The method of claim 13 or 14, wherein inflating the plurality of inner bladders further comprises: inflating the plurality of inner bladders with a gas.

16. The method of any one of claims 13-15, wherein inflating the plurality of inner bladders further comprises: inflating the plurality of inner bladders with a liquid.

17. The method of any one of claims 13-16, wherein inflating the plurality of inner bladders further comprises:

inflating at least two of the plurality of inner bladders to different pressures.

18. The method of any one of claims 13-17, wherein inflating the plurality of inner bladders further comprises:

inflating at least two of the plurality of inner bladders at different times.