[0004] Existing cylindrical filter modules suffer several shortcomings. One deficiency is that the circular pleated membrane unduly restricts fluid flow because the membrane must be more tightly packed towards the center in order to achieve the circular configuration. Another deficiency is that the cylindrical housings are molded or extruded as single pieces, making it difficult or impossible to add geometries that run perpendicular to the cylinder's axis. Furthermore, many existing filter modules are difficult to install and replace. Since many liquids used in semiconductor manufacturing are corrosive or toxic, filter module replacement presents a danger to workers.

[0005] Current filtration systems that employ cylindrical filters have limited configurability. In many cases, filters are connected through multiple units in a fixed configuration, making it difficult to change the flow through the filters from serial to parallel as needed. Additionally, many filtration systems use only a single type of filter, limiting the ability to apply different filters for different purposes or particle sizes in a single filtration system.

SUMMARY

[0006] Embodiments of modular purification systems and methods are described. One embodiment can include a compact pressure vessel that can be used as a purifier cassette or for another purpose. The pressure vessel can comprise a main body having a set of media cavity sidewalls that define an interior cavity. A first port can be fluidly connected to a first portion of the interior cavity and a second port can be fluidly coupled to a second portion of the media cavity.

[0007] According to a first aspect of the present invention, there is provided a purifier cassette comprising: a purifier body that further comprises a set of media cavity sidewalls at least partially defining a media cavity, the set of media cavity sidewalls comprising a first sidewall, a second sidewall, a third sidewall and a fourth sidewall, the first sidewall opposite the second sidewall and the third sidewall opposite the fourth sidewall; one or more tension members coupled to the first sidewall and the second sidewall of the media cavity, the one or more tension members dividing the media cavity into a plurality of lanes, the one or more tension members run parallel to the third sidewall and fourth sidewall; a main shell, the main shell further comprising: a base having openings to allow fluid to flow into or out of the plurality of lanes, the main shell sidewalls and tension members extend a length along a long axis of the media cavity to form lane sidewalls; lane covers coupled to the main shell and purifier element pleat packs disposed in the plurality of lanes in the media cavity, the first and last flap of each pleat pack captured between a lane cover and the sidewall or the

tension member, and the purifier element pleat packs pleated with the length of the pleat parallel to the long axis; the media cavity divided into an upstream portion and downstream portion by the purifier element pleat packs; a first purifier port fluidly connected to the media cavity, the first purifier port located upstream of the purifier element pleat packs; and a second purifier port fluidly connected to the media cavity, the second purifier port located downstream of the purifier element pleat packs.

[0008] According to one embodiment, the purifier body can be configured with reinforcing structures. According to one embodiment, the reinforcing structures comprise reinforcing ribs extending the length of the device (or other length) that can provide, in one embodiment, the dual functions of providing flow paths and reinforcing the main body. The reinforcing ribs may define arced, elliptical or otherwise rounded flow paths, thereby providing reinforcing arches. Thus, according to one embodiment, a series of reinforcing arches can define the flow paths along the sidewall.

[0013] The purifier cassette can further include a first end cap and a second end cap. An end cap can include a port fitting having a set of port fitting external threads, such as multi-start threads that configured to engage with inner threads of a connection nut. The connection system and fitting may include alignment features to help ensure that the fitting external threads and connection nut internal threads are properly aligned.

[0014] The connection system and cassette may include alignment features. In one embodiment, the alignment features of the fitting may include an alignment rib and a slot disposed in a rotation member receive the alignment rib. The alignment rib and slot may be configured so that the rotation member is rotated to a certain angle (e.g., corresponding to a position in which the threads are aligned) before the alignment rib can enter the slot. The alignment rib and slot may be helical.

[0015] The connection nut may include the connection system alignment features. In one embodiment, the connection nut can include a first alignment feature and the port fitting may comprise a second alignment feature spaced to align with the first alignment feature of the connection nut. According to one embodiment, the first alignment feature can be a set of inner projections and the second alignment feature can be a set of notches (e.g., defined in a port rib or elsewhere). The second alignment feature can be spaced from a start of a set of port fitting external threads such that inner connection nut threads cannot engage the set of port fitting external threads unless the alignment feature of the connection nut mates with the alignment feature of the fitting (for example, the inner projections are received by the notches). In some cases, the alignment feature of the connection system passes through the alignment feature of the fitting before the connection nut can rotate (or vice versa).

[0016] The alignment features can be configured so that only certain cassettes fit in certain manifolds (or particular positions within a manifold) (e.g., to ensure proper cassettes are used for certain applications). For example, the notch sets and inner projections can be altered in geometry, spacing, or other aspect for different fittings/connection nuts.

[0017] There is also provided an end cap configured to engage with a connection system that has a connection system fitting and a connection nut with a set of connection nut inner multi-start threads. The end cap can include a first port fitting that has a set of external multi-start threads configured to engage with the connection nut inner multi-start threads such that the first port fitting seals to a second fluid fitting with less than 360 degrees of rotation of the connection nut; and a first alignment rib spaced from an opening of the first port fitting. The connection nut internal threads can be configured to create a seal between the first port

fitting and another fitting with less than 360 degrees of rotation. In some embodiments, less than 360 degrees of rotation may result in at least 360 degrees or more of threaded engagement and in other embodiments may result

WHAT IS CLAIMED IS:

1. A purifier cassette comprising:

a purifier body that further comprises a set of media cavity sidewalls at least partially defining a media cavity, the set of media cavity sidewalls comprising a first sidewall, a second sidewall, a third sidewall and a fourth sidewall, the first sidewall opposite the second sidewall and the third sidewall opposite the fourth sidewall;

one or more tension members coupled to the first sidewall and the second sidewall of the media cavity, the one or more tension members dividing the media cavity into a plurality of lanes, the one or more tension members run parallel to the third sidewall and fourth sidewall;

a main shell, the main shell further comprising: a base having openings to allow fluid to flow into or out of the plurality of lanes, the main shell sidewalls and tension members extend a length along a long axis of the media cavity to form lane sidewalls;

lane covers coupled to the main shell and purifier element pleat packs disposed in the plurality of lanes in the media cavity, the first and last flap of each pleat pack captured between a lane cover and the sidewall or the tension member, and the purifier element pleat packs pleated with the length of the pleat parallel to the long axis;

the media cavity divided into an upstream portion and downstream portion by the purifier element pleat packs;

a first purifier port fluidly connected to the media cavity, the first purifier port located upstream of the purifier element pleat packs; and

a second purifier port fluidly connected to the media cavity, the second purifier port located downstream of the purifier element pleat packs.

2. The purifier cassette of Claim 1, wherein each purifier element pleat pack comprises a compressed generally rectangular pleat pack arranged with a first set of pleat tips facing an upstream portion of the media cavity and a second set of pleat tips facing a downstream portion of the media cavity.

3. The purifier cassette of any one of Claim 1 or 2, further comprising a first end cap and a second end cap.

4. The purifier cassette of any one of Claims 1 to 3, wherein the purifier body defines a plurality of hoop-like structures configured such that pressure in the media cavity causes tension in the first sidewall, second sidewall, third sidewall and fourth sidewall.

5. The purifier cassette of any one of Claims 1 to 4, wherein the purifier cassette further comprises:

a first side cover comprising the first sidewall and defining a first set of flow channels disposed along the first sidewall, the first set of flow channels connected to the first port; and

a second side cover comprising the second sidewall and defining a second set of flow channels disposed along the second sidewalls, the second set of flow channels on an opposite side of the plurality of sections from the first set of flow channels.

6. The purifier cassette of Claim 5, wherein the first side cover comprises a set of spaced reinforcing ribs defining a series of arches along the first sidewall and the second side cover comprises a set of spaced reinforcing ribs defining a series of arches along the second sidewall.

7. The purifier cassette of any one of Claims 5 or 6, wherein the first side cover defines a set of plenums at an entrance to the first set of flow channels.

8. The purifier cassette of any one of Claims 5 to 7, wherein the second side cover is coupled to a base and the first side cover is coupled to a distal end of the third sidewall, a distal end of the fourth sidewall and distal ends of the one or more tension members.

9. The purifier cassette of any one of Claims 5 to 8, wherein the first side cover comprises a set of spaced reinforcing ribs defining a series of arches along the first sidewall and the second side cover comprises a set of spaced reinforcing ribs defining a series of arches along the second sidewall.

10. The purifier cassette of any one of Claims 1 to 9, wherein the purifier cassette comprises an alignment feature configured to align with a corresponding alignment feature of a connection system.

11. The purifier cassette of Claim 10, wherein the alignment feature comprises a radial port rib positioned to be received by the corresponding alignment feature of the connection system.

12. The purifier cassette of Claim 10, wherein the alignment feature is spaced from a start of a set of port fitting external threads a distance such that a set of port fitting external threads cannot engage a set of connection nut internal threads unless the alignment feature mates with the corresponding alignment feature of the connection system.

13. The purifier cassette of Claim 12, wherein the alignment feature comprises a set of notches configured to align with a set of inner projections of the connection nut.

14. The purifier cassette of any one of Claims 1 to 13, further comprising a first port fitting having external multi-start threads configured to engage with a set of connection nut inner multi-start threads such that the first port fitting seals to another port fitting with less than 360 degrees of rotation of the connection nut.

15. The purifier cassette of any one of Claims 1 to 14, wherein the purifier cassette is an all polymeric purifier cassette.