Title: TUBING CONNECTOR, METHOD OF MANUFACTURE, AND METHOD OF ASSEMBLY

Abstract: A coupling utilizes a tubing end portion with a bulbous shape on the exterior and a corresponding interior bulbous shape, the tubing end that engages with a fitting body with a bulbous shape and converging annular slot. The invention includes a method of forming, the method of making the components of the coupling, including specifically the bulbous tubing end portion and the fitting body, the method of making the connection. The invention includes the various components individually and together as a system or a coupling. The invention includes specific fluid flow components with such a coupling attached.
before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments
TUBING CONNECTOR, METHOD OF MANUFACTURE, AND
METHOD OF ASSEMBLY

Related Application

The present application claims the benefit of U.S. Provisional Application No. 60/917,880 filed May 14, 2007, which is incorporated herein in its entirety by reference.

Field of the Invention

This invention relates to couplings for plastic tubing, more particularly the application relates to couplings for handling ultra pure fluids used, for example, in the semiconductor processing industry, methods of manufacturing such couplings, and methods of assembly of such couplings.

Background of the Invention

Numerous industries use tubing and fittings of fluoropolymers, e.g., perfluoroalkoxy (PFA), polytetrafluoroethylene (PTFE), and other synthetic resins, for the transfer of various fluids in extreme temperatures and conditions. These fluoropolymer fittings offer extraordinary corrosion resistance and high purity which make the materials ideal for the semiconductor processing industry. However, such plastic fittings and tubings, in that they are made of plastic rather than traditional materials such as stainless steel, bronze and copper, do not have the rigidity and strength of conventional fittings. Thus particular connection configurations that may work very well with metal fittings and metal tubing, do not work adequately when made from polymer and particularly fluoropolymer materials. To maintain a clean and non-hazardous process it is essential that the fittings provided for coupling sections of tubing are not easily disconnected and that the integrity of tubing/fitting interface is maintained. Various types of fluoropolymer fittings have been provided for these purposes.

One standard type of fitting known as FLARETEK® fitting, available from the assignee of this application, provides for a fitting body, having a nose with a rounded tip and cylindrical section, and a threaded portion at the base of the nose. A fitting nut is typically placed on the tubing before the tubing end is flared. The end portion of tubing with the flared end is placed over the nose section and the fitting nut is slid over and secured to the fitting body axially compressing the flared end on the nose by the collar of the nut creating a seal between the inside surface of the tubing and nose. When assembled
the nut extends completely over the flared section. The seal is created around the substantially cylindrical nose but is principally at the tip of the nose. In these fittings, the inside diameter of the flared section is slightly greater that the outside diameter of the non-flared portion of the tubing. The tubing flare forms an exaggerated s-shape with the flared section axially extending and having a constant diameter. The flare is formed by heating the end of the tubing and expanding same on an appropriately shaped form.

Such flared fitting bodies have the nose portion including the portions which seal exposed when they are unassembled subjecting the fitting bodies to potential damage. Similarly, the exterior threads are also exposed subjecting them to possible damage. However in certain applications it would be desirable to have a flared fitting that offers further advantages such as additional secondary sealing, a fitting in which the sealing surfaces of fitting body are not exposed when the fitting is unassembled, and moreover that provides more protection to the sealing components when assembled.

Another coupling that has gained acceptance in these applications is reflected in U.S. Patent Nos. 5,154,453 and 5,743,572. These fittings are known as Pillar fittings and utilize a very high tolerated ring insert that is inserted and retained into a tubing end. The insert forces the tubing into a bulbous shape on the exterior and has a cylindrical bore on the interior of the insert. The bulbous shape provides an excellent shape for sealing with a fitting but requires a permanently placed insert to maintain the bulbous shape. The deformed tubing end with the insert is engaged into another highly tolerated fitting body and is secured thereto with a nut that engages with threading on the exterior of the fitting body. The nut provides axial force to the bulbous shape opposite the tip of the tubing end to seal the tubing end and insert to the fitting body. Although these fittings provide a coupling of high integrity, particularly provided by the bulbous exterior of the tubing, they are difficult to manufacture to the exacting tolerances needed.

**Summary of the Invention**

A coupling utilizes a polymer tubing end portion with an expanded end, such as a bulbous shape on the exterior and a corresponding interior bulbous shape, the tubing end portion engages with a fitting body with a bulbous exterior surface and an annular slot adjacent to the bulbous exterior surface, the tubing end portion and fitting are coupled together with a nut that pulls the tubing end portion and fitting body together. The slot has
opposing annular surfaces, in preferred embodiments, the slot has a converging portion where both surfaces are parallel with respect to one another and converge radially inward.

In a preferred embodiment of the invention, the polymer is resilient and has a memory such that the bulbous shape at the tubing end portion may be formed by inserting and withdrawing a bulbous mandrel into the tubing end to be joined. The bulbous shape has a maximum radius away from the tip of the tubing end portion. The operation of insertion and withdrawal of the mandrel can conveniently be accomplished at room temperature. Preferably the mandrel is inserted by first securing a gripping ring assembly to the exterior of the tubing distally position from where the bulbous portion will be formed opposite the tip of the tubing end portion, and utilizing the gripping ring assembly to secure the tubing while the mandrel is being inserted and remove to preform the bulbous shape. Preferably the gripping ring assembly is permanently attached and also provides a engagement member for a nut when the tubing end portion is attached to the fitting body. The gripping ring assembly may have a gripping ring with plurality of axially extending fingers, spaced circumferentially, with gripping teeth at the ends of the fingers. A second locking ring portion slides radially onto the gripping ring with a wedge action to press the gripping teeth into the exterior of the tubing. The gripping ring assembly may have an exterior facing cam wedge surface to allow the nut to slide over the assembled gripping ring assembly and be retained thereon.

In a preferred embodiment, a connection is made by radially expanding a tubular end portion, with the radial expansion extending axially over an axial distance of at least 2 times the original radii of the tubing. In a preferred embodiment from the tip of the end portion, after the radial expansion, the radius of the tubing portion increases initially from the tip with the measured radii moving away from the tip and then decreases to the original tubing radius. In a particular embodiment, the expansion is performed at room temperature, or at a temperature from 60 degrees Fahrenheit to 90 degrees Fahrenheit.

In a particular embodiment the tubing end portion is radially expanded by a mandrel that the mandrel having an insertion head with a tip having a tapered portion, and a cylindrical portion or a bulbous portion with a radial dimension greater than the inside dimension of the tubing. The mandrel may be fully inserted during the expansion so that the decreasing radius portion of the mandrel is at least at the tip of the tubing end portion.
In a preferred embodiment, the fitting body has an exterior threaded portion, a bulbous shaped male portion, partially covered by the threaded portion, the bulbous portion and threaded portion defining an annular slot that converges inwardly and is sized to sealingly receive the tubing end with the preformed bulbous shape. The method also includes a technique to manufacture the undercut portion of the annular slot that converges radially inward.

In certain embodiments, the fitting body may be formed of two portions, an inner body portion and an outer body portion. The inner portion having a fluid flow bore and surface, the bulbous exterior surface and the inner surface that faces outwardly of the two surfaces of the annular groove. The outer portion having the outer surface that faces inwardly, and in a preferred embodiment, a threaded

An advantage of the invention is that manufacturing tolerances are not as strict as with other bulbous connectors. Moreover, fewer leakpaths are presented than in other connectors that use bulbous connections.

An aspect of the invention is that the bulbous shape can surprisingly be formed in desireable polymers, such as perfluoroalkosy (PFA) by the simple insertion and withdrawal of a mandrel that has a bulbous shape slightly larger than the remaining bulbous shape. The maximum diameter portion of the mandrel is inserted past the tip a desired distance and is then withdrawn. The memory of the PFA retains a reduced shadow version of the bulbous shape of the mandrel and significantly has the tip at a lesser diameter than maximum diameter of the bulbous shape. Without inside support of the bulbous shape, over a period of a plurality of hours the bulbous shape will fade and return to the original or near original shape of the tubing end portion. The connection between the bulbous shaped tubing end portion and the cooperating fitting is accomplished typically momentarily, that is a few minutes, after making the bulbous shape so the return to the original shape is not an issue. This delayed resiliency, or memory of the original tubular shape, is a positive feature in that it serves to maintain the seal between the inside surface of the bulbous portion of the tubing end portion and the outside sealing surface of the fitting body portion.

A further advantage is that the bulbous shape of the tubing end can be formed manually with simple tools. A further advantage is that the undercut portion of the fitting
can unexpectedly be injected molded and with minimal moving parts (mold inserts) in the mold.

An aspect of the invention is a method of making a connection between a PFA polymer tubing end portion and a polymer fitting by cold forming the end portion utilizing a mandrel to conform to an annular recess in the polymer fitting.

An aspect of the invention herein is a method of making a fluid flow connection as described and illustrated herein.

Aspects of the invention herein include the individual components and the method of forming or manufacturing same. Specifically the bulbous tubing end portion and the fitting with the bulbous exterior sealing surface and annular slot which may be converging. The fitting may be formed by injection molding or machined from two pieces if PTFE is utilized.

An aspect of the invention herein is a fluid flow valves, sensors, filter bodies, manifolds, flow controllers with a component of the connection described and illustrated herein.

An aspect of the invention herein are the tools to accomplish the manufacture and/or assembly of the components and/or connector described and illustrated herein, as well as a kit comprising same.

**Description of the Figures**

Figure 1 is a cross-sectional view of a coupling according to embodiments of the invention herein.

Figure 2 is a perspective view of a tubing portion with the bulbous portion, and gripping ring assembly, and nut thereon ready and a cooperating fitting body integral with a generalized fluid flow component body according to embodiments of the invention.

Figure 3 is a cross-section of a fitting body, tubing end portion ready for coupling according to embodiments of the invention.

Figure 4 is a perspective view of a locking ring assembly according to embodiments of the inventions.
Figure 5 is a perspective view of a nut on a tubing end portion prior to forming the bulbous portion.

Figure 6 is a cross sectional view of another embodiment of a coupling.

Figures 7 through 10 illustrate the technique of forming the bulbous shape in the tubing end portion in cross section.

Figures 11 through 13 are views of a manually operated tool suitable for installing the gripping ring assembly on the tubing portion and suitable for inserting and removing the mandrel according to embodiments of the invention, illustrated with the connector components.

**Detailed Description of the Invention**

Referring to Figures 1, 2, and 3, the principal components of the coupling 12 or connector are illustrated. Tubing 18 having a tubing end portion 20 has a continual wall 21 with a bulging or bulbous portion 22 having a bulbous exterior surface 24, a bulbous interior surface 26, a tip 28 with an opening 29, and a non-deformed or uniform radius portion 30. The tip has an inside diameter d1 and radius r1. The tubing has an inside radius r2 which is also the inside radius of the uniform radius portion. The inside radius of the bulbous portion increases as the distance from the tip increases to the point of maximum radius as illustrated by radius r3. The inside radius of the bulbous portion then decreases to the tubing radius r2 or may go slightly lower that the tubing radius due to the gripping ring assembly discussed below.

Said tubing end portion 20 is engageable or engaged in the various views with a fitting body portion 32. The fitting body portion 32 may be integral with a fluid flow component body portion 34, such as a valve body, a manifold, a flow controller, a filter body, a tee, a sensor body, or other components. The fitting body portion 32 has a nose 35 with an outside or external radius r4, a bulging or bulbous portion 36 with an externally facing sealing surface configured as an exterior facing bulbous surface 38 having an outside radius r5. A substantially cylindrical bore 40 with an axis α constituting a fluid flow passageway extends through the fitting body portion 32. The bore will preferably have a radius r6 equal to the tubing radius r2. The fitting body portion has an annular slot 42 for receiving and sealing with the tubing end portion tip 28. The slot has an outwardly facing surface 43, an inwardly facing surface 44, and a slot bottom 45, all of which can provide sealing engagement with corresponding surfaces of the tubing end portion to
effectuate the seal of the coupling to prevent leakage of the coupling. The exterior facing bulbous surface 38 is contiguous and coextensive with the outwardly facing surface of the annular slot.

Referring to Figures 1, 3, and 4, a gripping ring assembly 52 secured on the tubing portion has a gripping ring 54 with axially extending and radially flexing gripping claws 55, separated by gaps 56, and a wedge locking ring 58 that cooperates with the gripping ring. The gripping ring also may have a locator tab 56 that mates with an aperture 57 on the locking ring. Wedge shaped locking tabs 59 on the gripping ring may be provided to lock the assembly together on the exterior surface of the tubing.

Referring to the figures, a nut 60 with inwardly facing threads 62 engages the exterior threads 70 of the fitting body. The nut has a stop surface 74 which engages a flange 76 on the body portion. Also wedge or cam portions 61 may extend from the locking ring or alternatively the gripping ring to provide a locking action with the nut 60 to retain or fix the axial position of the nut on the tubing end portion where the gripping ring assembly is secured. Moreover, the axial fixation of the nut on the tubing end portion allows the unscrewing of the nut from the fitting portion to pull the bulbous portion of the tubing end portion off of the bulbous portion of the fitting portion. A pusher portion 80 of the nut engages the gripping ring assembly 52 and thereby the tubing end portion. Flats 82 may be provided to aid in screwing the nut onto the fitting.

Figures 2 and 3 illustrate the coupling ready to be assembly into a connection of high integrity. Figure 1 is the "made" high integrity connection. Note the nut 60 freely rotates on the tubing end portion 20. The bulbous portion 22 of the tubing portion confronts and contacts the nose of the fitting body, at which contact point the nut 60 may be threadingly engaged with the exterior threads of the fitting body portion. Rotation of the nut then urges the bulbous portion of the tubing end portion forward (toward the fitting body) by way of axial contact with the gripping ring assembly such that the bulbous portion 22 of the tubing portion slides over and sealingly engages with the bulbous portion 36 of the fitting body and said tubing end portion is sealingly engaged in the slot 142 of the fitting body.

Significantly, in preferred embodiments, the inside radius r1 of the tip 28 of the tubing end portion is greater that the outside radius of the nose of the fitting body portion 32 allowing easy guiding and orientation of the tubing portion to facilitate the engagement
of the tubing portion around the fitting body portion bulbous portion. Note that in certain embodiments, the outside radius r4 of the bulbous portion of the fitting body portion is greater that the inside radius r1 of the tip 28. This necessitates some expansion of the opening of the tip when the components are engaged together. Also preferably, the inside radius of the inside bulbous surface r3 is less that the outside radius r5 of the bulbous portion of the fitting body portion which facilitates a secure sealing engagement between the respective surfaces, that is, the inside bulbous surface of the tubing end portion and the outside bulbous surface of the bulbous portion of the fitting body portion.

The fitting body 32 has the bulbous end and an opposite connecting end 110 that may be attached to other fluid components integrally or by way of conventional connections or by way of another connection as described herein. Said fitting body may be an integral part of a valve or a fluid flow measurement device or connection such as a tee or elbow. The fitting body has a threaded portion 132 which in conjunction with the bulbous portion 36 defines the inwardly converging slot 142. Said slot is sized for receiving the tip and a portion of the bulbous portion of the tubing end portion.

Referring to Figure 6, an alternative embodiment is illustrated in which the fitting body portion 210 is comprised of an inner portion 214 and an outer portion 216 that are threadingly coupled together and sealingly coupled at a dovetail connection 220. The inner portion and outer portion define the annular slot 222. Such a slot is very difficult to machine and where the fluid flow component body 230 is made of PTFE, which can't be conventionally molded, and is integral with the fitting body portion, the two portions allow this coupling configuration to be utilized. This figure also illustrates a correct coupling indicator ring 240, that may provide an audible or visual indication that the nut is sufficiently or properly tightened on the fitting body portion. The indicator ring 240 is received in a first circumferential groove 244 before assembly and when the nut is tightened on the fitting body portion the indicator ring abuts against a stop surface 248 of the fitting body portion and as the nut is further tightened, that is moved axially, the indicator ring is pushed and eventually "pops" audibly to the second circumferential groove 250. Coloration such as red stripes in the grooves may be added to facilitate visual indication of the sufficiency of lack thereof of the connection.

Figures 11, 12, 13 illustrates a suitable hand operated tool 300 which can be utilized for locking the securement ring to the gripping ring at a suitable position on the tubing end portion. The tubing end portion be secured axially with the U-shaped bracket
A mandrel 310 is illustrated which is internal in the cylinder 314 and is tightened by way of the manual nut 218 in order to create the bulbous end portion. The mandrel may then be backed out with same rotatable handle.

The mandrel inserted in a tubing end portion is illustrated in Figure 8. After removal of the mandrel, the tubing end portion retains the bulbous shape as illustrated in Figure 2. Surprisingly, the bulbous shape converges towards the end face 220 of the tubing end portion. A component is principally made of fluid polymers such as PFA or PTFE. The gripping ring may be made of a more rigid polymer such as PEEK (polyetheretherketone).

Referring to Figures 1-3 and 7-10, detailed steps in making and assembling a coupling in accord herewith are as follows: First the nut 60 is slid on an deformed tubing end portion 20 to be joined. Next, the gripping assembly 52 is suitably positioned on the tubing end portion intermediate the tubing end face and the nut. The locking ring 58 is secured over the gripping ring 54 to lock the gripping ring assembly into place on the exterior of the tubing end portion. A manual or automatic tool may be is utilized for this connection by providing the positioning and clamping. Such a manual hand tool or automatic tool may then be utilized to insert the mandrel 210 into the tubing end portion and then retracting same immediately to form the bulbous portion utilizing the gripping assembly to provide an axial support while the mandrel is inserted and withdrawn. Said operation may preferably be done at room temperature. The mandrel inserted in a tubing end portion is illustrated in Figure 8. After removal of the mandrel, the tubing end portion retains the bulbous shape as illustrated in Figures 10 and 2. Surprisingly, the bulbous shape converges towards the end face 220 of the tubing end portion. A component is principally made of fluid polymers such as PFA or PTFE. The gripping ring may be made of a more rigid polymer such as PEEK (polyetheretherketone).

The fitting body 32 may already be secured to a fluid flow component or fluid flow plumbing or may now be appropriately secured such as by a welding connection. The tubing end portion then is confronted with the bulbous portion of the fitting body and the nut 60 is engaged with the threads of the fitting body. Rotation of the nut onto the threaded body preferably until said nut engages the flange 76 of the fitting body moves the bulbous portion of the tubing end portion over the bulbous portion of the fitting body, expanding the opening at the tip, and sealingly engages the bulbous portion of the tubing end portion onto the bulbous portion of the fitting body portion and into the converging annular slot.
In certain embodiments, the tubing may be heated during the processing, such as before the mandrel is inserted or after the mandrel is inserted. Where the heating is done with the mandrel inserted as shown in Figure 9, the tubing may be allowed to cool before withdrawing the mandrel to better retain the bulbous shape.

Note that the fitting body may be injection molded with a central bore mold insert and a secondary removable molding insert shaped to the converging slot or recess 142. After the molten plastic is injected into the mold and allowed to cure the central bore insert may be removed which allows the secondary insert mold insert for the converging recess or slot to then be removed causing radial inward temporary flexing of the bulbous portion of the fitting body without significantly deforming said bulbous portion of the fitting body.

The present invention may be embodied in other specific forms without departing from the spirit of the essential attributes thereof; therefore, the illustrated embodiments should be considered in all respects as illustrative and not restrictive, reference being made to the appended claims rather than to the foregoing description to indicate the scope of the invention.
Claims

1. The method of making a connection between a polymer tubing end portion and a polymer fluid flow component body portion, the fluid flow component body portion integral with a fitting body portion configured as bulbous portion with an externally facing sealing surface and having a fluid flow contact surface defining a fluid flow passageway, the method comprising the steps of:

   forming the tubing end portion into a bulging portion with a bulbous shape having a bulbous internal inwardly facing sealing surface and a bulbous external surface and with a convergent tip having an opening smaller diametrically than external facing sealing surface of the bulbous portion of the fitting body;

   radially expanding the tip of the tubing end portion over the bulging portion and having the tip resiliently retracts after the tip is passed over the bulbous shape by axially forcing the tip over the bulging portion; and

   seating the tip in an annular slot in the fitting body portion.

2. The method of claim 1 wherein the tubing end portion if formed into a bulging portion by inserting and momentarily retracting a mandrel and selecting the mandrel size whereby memory in the tubing end portion retains a shape reflective of the mandrel for a period of time of at least one hour.

3. The method of claim 1 further comprising the step of attaching a gripping ring assembly to the exterior of the tubing end portion, the gripping ring assembly comprising a ring with gripping claws that extend in an axial direction and are flexible radially, and a wedging ring that cooperates with the ring with gripping claws to force the gripping claws radially inward to secure the gripping ring assembly to the exterior of the tubing end portion.

4. The method of claim 3 further comprising the step of rotatably attaching a nut to the tubing end portion at the gripping ring assembly and screwing the nut onto a threaded portion on the fitting body portion whereby the tubing end portion and fitting body portion are pulled by the tightening of the nut on said threaded portion.
5. The method of claim 4 further comprising the step of stopping the 
tightening of the nut when an appropriate rotational position is reached as indicated by a 
audible signal from a tightness indicator ring engaged with the nut.

6. The method of claim 1 wherein the tubing end portion is formed into a 
bulbous portion by inserting and retracting a mandrel sized larger that the bore in the 
tubing end portion and wherein the inserting and retracting is done without heating the 
tubing end portion.

7. A method of making a connection between a polymer tubing end portion 
with an opening at the end, the tubing end portion formed of perfluoroalkoxy, the method 
comprising the steps of:

    deforming the polymer tubing end portion by inserting and withdrawing a mandrel 
    into the tubing end to provide a bulbous shape at the end portion including an interior 
    bulbous shape that will return to the original tubing shape after a plurality of hours; and

    connecting the tubing end portion onto a fitting body portion before the end portion 
    returns to the original tubing shape, the fitting body portion having a fluid flow passage 
    way therethrough and a bulbous shape slightly larger that the interior bulbous shape of the 
tubing end portion.

8. The method of making a connection between a polymer tubing end portion 
and a polymer fluid flow component body portion, the fluid flow component body portion 
integral with a fitting body portion configured as bulbous portion with an externally facing 
sealing surface and having a fluid flow contact surface defining a fluid flow passageway, 
the method comprising the steps of:

    forming the tubing end portion into a bulging portion that retains a bulbous shape 
    without internal support, the bulging portion having a bulbous internal inwardly facing 
    sealing surface and a bulbous external surface and with a convergent tip having an 
    opening smaller diametrically than external facing sealing surface of the bulbous portion 
of the fitting body;
radially expanding the tip of the tubing end portion over the bulbous portion of the fitting body portion and having the tip resiliently retract after the tip is passed over the bulbous shape by axially forcing the tip over the bulging portion; and

seating the tip in an annular slot in the fitting body portion, and securing the tubing end portion to the fitting

9. The method of claim 8 further comprising the step of rotatably attaching a nut to the tubing end portion and tightening the nut onto a threaded portion on the fitting body whereby the tubing end portion is secured to the fitting body.

10. The method of claim 9 wherein the nut further comprises a ring extending around said nut and has an original position and a secondary position axially displaced from the first position, the ring adapted to provide an audible sound when forcibly moved from the original position to the secondary position and the method further comprises the step of tightening the nut onto the fitting body portion and stopping upon the audible sound is produced.

11. The method of claim 9 further comprising the step of axially fixing in both directions the nut to the tubing end portion at a gripping ring assembly, whereby the coupling can be disassembled by unscrewing the nut on the fitting body.

12. A coupling comprising a tubing end portion and a fitting body, the tubing end portion having a continual wall, the tubing end portion having a uniform radius portion, an intermediate sealing portion, and a tip; the uniform radius portion, the intermediate sealing portion and the tip all integral with one another; the tip having an opening with an inside tip radius, the radius of the uniform radius portion having a tubing inside radius, the tip inside radius being larger than the tubing inside radius, the intermediate sealing portion having an inside radius that increases from the tip radius toward the uniform radius portion with a maximum inside radius and then decreases to the tubing inside radius defining a bulging portion with an inwardly facing sealing surface;
a fitting body having a fluid flow passage way for communication with the fluid flow passage way of the tubing end portion, the fitting body comprising a bulbous portion with a nose to confront and engage the tubing end portion, the nose configured to fit within the opening of the tip of the tubing end portion, the bulbous portion having an outside radius greater than the inside radius of the tip of the tubing end portion, the fitting body further comprising an annular slot partially defined by the bulbous portion and sized to receive the tip of the tubing end portion; and

a nut for coupling the tubing end portion and fitting body together;

whereby at least one of the tip of the tubing end portion expands and the bulbous portion of the fitting body contracts as the tubing end portion and fitting body are coupled into a sealing coupled position.

13. The coupling of claim 12 wherein the fitting body is integral with one of a valve body, a tee, a flow controller portion, a filter portion.

14. The coupling of claim 12 wherein the annular slot of the fitting body has an inwardly facing surface and an outwardly facing surface, and wherein the fitting body is comprised of an inner portion having the fluid flow passageway and the outer facing surface of the annular slot, and an outer portion having the inwardly facing surface of the annular slot and threadably coupled with the inner portion.

15. The coupling of claim 14 wherein the inner portion and outer portion of the fitting body are sealingly coupled by an annular tongue-in-groove connection.

16. The coupling of claim 12 further comprising a correct coupling indicator ring peripherally located on the coupling and abuttingly engageable with one of the fitting body and nut and having two engagement positions on the other of the fitting body and nut whereby the correct coupling indicator ring is axially translatable from one of the positions to the other upon torquing the nut onto the fitting body.
17. The coupling of claim 12 further comprising a gripping ring assembly secured exteriorly to the tubing end portion proximate the uniform radius portion and the bulging portion, the nut engaging the gripping ring assembly for pulling the tubing end portion and fitting body together.

18. The coupling of claim 17 wherein the nut is restrained axially on the gripping ring assembly whereby the coupling may be uncoupled by pulling the tubing end portion away from the fitting body portion wherein the tip of the tubing end portion temporarily expands as it is pulled over the bulbous portion of the fitting body portion.

19. A fluid coupling for connecting a fluid device to a fluid circuit, the coupling comprising a polymer tubing end portion having a interior bulbous surface and an exterior surface with a gripping ring attached thereto;

a fitting body portion with an exteriorly facing bulbous surface, an annular recess partially defined by the exteriorly facing bulbous surface, a cylindrical bore extending through the fitting body portion, the interior bulbous surface of the tubing end portion sized to sealingly engage the exteriorly facing bulbous surface of the fitting body portion, the annular recess sized to fittingly receive the tubing end portion.

20. The fluid coupling of claim 19 wherein the annular recess of the fitting body has an inwardly facing surface and an outwardly facing surface, and wherein the fitting body is comprised of an inner portion having the fluid flow passageway and the outer facing surface of the annular slot, and an outer portion having the inwardly facing surface of the annular slot, the outer portion threadably coupled onto the inner portion.

21. A method of providing a coupling between perfluoroalkoxy tubing a fluid flow device having a body portion formed of polytetrafluoroethylene, the method comprising the steps of:

machining a fitting body portion integral with the body portion of the fluid flow device, the fitting body portion having a bulbous portion with a bulbous shaped exteriorly
facing sealing surface and a central axially extending cylindrical fluid flow passage way extending through the bulbous portion;

    shaping a tubing end portion of the perfluoroalkoxy tubing into a bulbous shape conforming to the bulbous shape of the fitting body portion, including an interior bulbous shape, by inserting and withdrawing a mandrel into the tubing end, the mandrel sized such that the tubing end portion retains the bulbous shape after the mandrel is withdrawn;

    forcing the tubing end portion over the bulbous portion of the fitting body; and

    securing the tubing end portion to the fitting body.

22. The method of claim 21 further comprising the step of machining a converging annular slot extending in an axial direction into the fitting body whereby the exteriorly facing bulbous sealing surface partially defines said annular slot.

23. A method of forming a bulbous tubing end portion of perfluoroalkoxy for use in a fitting, the method comprising the steps of:

    Inserting a bulbous shaped mandrel sized larger than the tubing opening of a perfluoroalkoxy tubing end portion into the tubing opening, and then withdrawing the mandrel.
A. CLASSIFICATION OF SUBJECT MATTER

F16L 19/02(2006.01)1, F16L 15/04(2006.01)1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 F16L 19/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models since 1975

Japanese utility models and applications for utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS(KIPO internal) & keyword "tube", "joint", "coupling", "connector"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Date of the actual completion of the international search

03 NOVEMBER 2008 (03 11 2008)

Date of mailing of the international search report

03 NOVEMBER 2008 (03.11.2008)

Name and mailing address of the ISA/KR

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