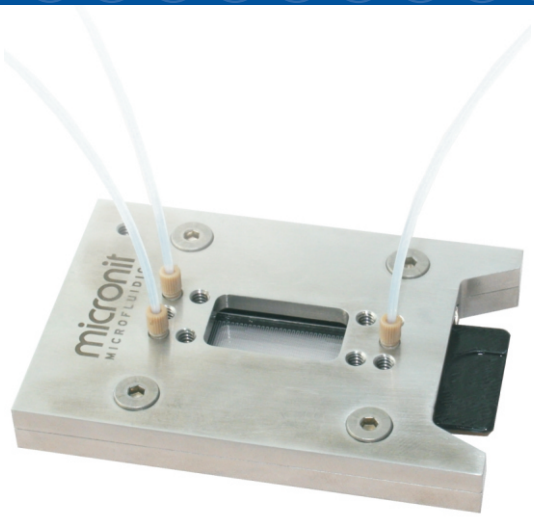
micronit

MICROFLUIDICS

FLUIDIC CONNECT 4515

User Manual - Version 1.5



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CONTENTS

1 INTRODUCTION

This manual describes the use of Fluidic Connect 4515 and the installation of the microfluidic chips and the Fluidic Connections. Three different connections will be described in this manual:

Fused Silica Connections

- fused silica capillaries (375 µm OD, 150 µm ID), 'Nanoport' ferrules and nuts

Stainless Steel Connections

- stainless steel tubing (1/16" µm OD, 250 µm ID), 'Flat-bottom' ferrules and nuts

Teflon Connections

- teflon tubing (1/16" µm OD, 250 µm ID), 'Flat-bottom' ferrules and nuts

The chip holder has viewing windows in top and bottom parts. These openings allow the chip to be inspected while in the chip holder, using an inverted or standard microscope. Multiple chips can be connected in parallel or in series for additional flexibility.

Key features of Fluidic Connect 4515:

- User friendly, leak-free microfluidic connections
- Easy chip replacement thanks to Fluidic Slide
- Improved alignment of the microfluidic chip
- Improved chip support to prevent chip breaking
- Chemically inert materials (sealing rubbers, chip and chip holder)
- Smaller distance between chip and microscope objective
- Larger chip area to detect with microscope objective
- Chips can be connected in series or in parallel using multiple holders

2 ASSEMBLY AND ADJUSTMENTS

In this section, the assembly of the chip holder will be discussed step by step. Please pay attention to step 4, as this step contains two different assembly methods, depending on the type of Fluidic Connection Kit that is used.

2.1 STEP 1: PARTS CHECK

Check the parts list on page 18 to see if all the parts are included.

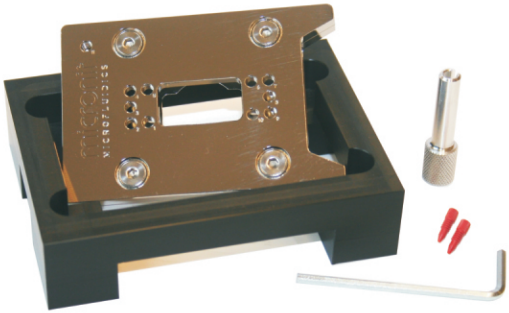

Figure 2.1. All the parts of Fluidic Connect 4515

2.2 STEP 2: CHIP PLACEMENT

Clean the chip holder and place the chip in the chip holder. The user-friendly design allows the user to push (slide) the chip into the chip holder over a flat surface (see Figure 2.2). Make sure that the arrow on the chip cartridge directs to the holder.

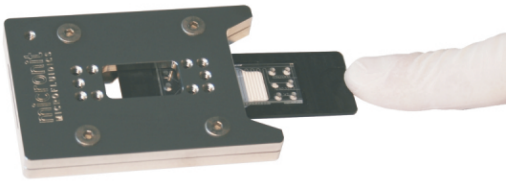

Figure 2.2. Slide the chip into the chip holder

2.3 STEP 3: PLACING THE ALIGNMENT NUTS

With the Fluidic Connect 4515 two alignment nuts are supplied. The alignment nuts are needed to guarantee good alignment of the chip and should be used after the chip has been placed in the chip holder and before the fluidic connections are made.

Screw the alignment nuts into the alignment ports (see Figure 2.3 and Table 2.1). It depends on the type of chip what ports you should use as alignment ports. You only need to slightly press the nuts into the ports to align the chip properly.

Do not over tighten the alignment nuts; this might damage the chip!

The alignment nuts will position the chip such that the holes in the chip are concentrically to the ports in the chip holder.

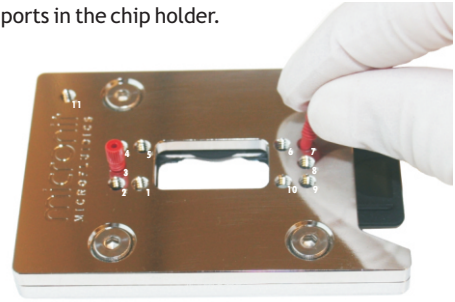

Figure 2.3. Screw the alignment nuts gently into the chip holder

	Fluidic ports	Alignment ports
Microreactor Chips	2, 4, 8	3, 7
Cross Channel Chips	1, 3, 5, 8	2, 7
Micromixer Chips	6, 8, 10	3, 7
Electrode Chips	3, 8	2, 7
Flowcells	2, 3, 4, 7, 8, 9	1, 6

Table 2.1. Fluidic ports and alignment ports per chip type

2.4 STEP 4: CONNECTION OF FITTINGS

Now the fluidic connections can be made. Since different connection types require different procedures, the connection procedures are described separately below. The procedure for the Fused Silica Connection Kit is described in **Step 4A**, for the Teflon and Stainless Steel Connection Kit the description can be found in **Step 4B**.

Note that over tightening can break the glass chip, especially when working with a thin-bottom chip like the R50.332.3 or the X3550CH.3 chip. Use the following protocol to avoid breaking of microfluidic chips.

Step 1. To tighten finger tight, you should twist the connection with the tip of your thumb and index finger, until you feel the ferrule pressing onto the chip (tightening resistance increase). You should not try to get a better grip on the connection, just proceed with step 2.

Step 2. After finger tightening, tighten the nut with the extender tool:
- another 1/4 round for Flat-Bottom connections (Teflon / Stainless Steel)
- another 1/3 round for Nanoport connections (Fused Silica)

2.4.1 STEP 4A - FUSED SILICA CONNECTION KIT

Step 4A is specifically for the Fused Silica Connection Kit.

1. **Adjusting capillary length**

   The 'Nanoport' ferrules and nuts supplied with the Fused Silica Connection Kit enable low dead-volume connections, using fused silica capillary tubing of 375 µm outer diameter.

   Various tools are available for cutting capillaries to the required length. The capillary can be cut with a straight edge using a dedicated tool. A well-defined cut is important in order to minimize the dead volume in the connection between the capillary and the chip. Alternatively, the capillary can be cut using a sharp knife.

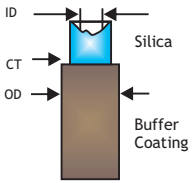

Figure 2.4. Fused silica with a polyimide coating

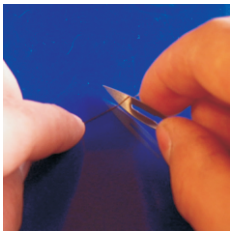

Figure 2.5. Cutting the capillary

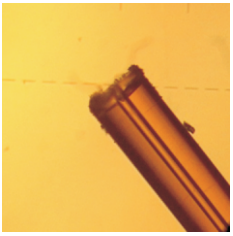

Figure 2.6. Capillary that has been cut

Fused silica capillaries have a protective polyimide coating on the outside (see Figure 2.4). A scratch can be made into the silica by cutting through the coating with a sharp blade (Figure 2.5). When bending the capillary it will break at the scratch. This is an easy way to cut the capillary to the required length. Note that the end of a capillary that is cut using the above procedure generally is not completely straight (Figure 2.6), unlike the end of a pre-cut and polished capillary. The latter are commercially available from various capillary tubing suppliers.

2. Connecting the ferrules

After cutting the capillaries to length, the ferrules need to be added. First slide the nut over the capillary (Figure 2.7.1) followed by the sealing ferrule. Either the flat side or the conical side of the ferrule should be flush with the tip of the capillary (Figure 2.7.3). The capillary should not protrude (Figure 2.7.2).
The ferrule can be used in two different ways:

- with the conical side down, pressed into the conical hole of the chip (lowest dead volume)
- with the conical side up, flat area of the ferrule will be pressed onto the glass (for high pressure connections)

It is advised to use latex gloves during handling, in order to prevent contamination of the ferrules. Also rinse the ferrules with deionized (DI) water to make sure they are clean. The ferrules are made of PERLAST™. This material is chemically resistant to most solvents.

Figure 2.7.1. Fitting over cap

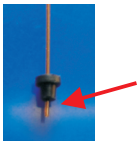

Figure 2.7.2. Wrong

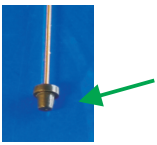

Figure 2.7.3. Like this

After fitting the ferrules onto the capillary, the capillary should be rinsed to remove any glass particles resulting from cutting the capillary. Filtered deionized (DI) water is advised for flushing the capillary.

3. Making fluidic connections

At this stage you can place the fittings in the appropriate fluidic ports (see Table 2.1). The fittings can be tightened individually by hand using a special extender tool (Figure 2.8).

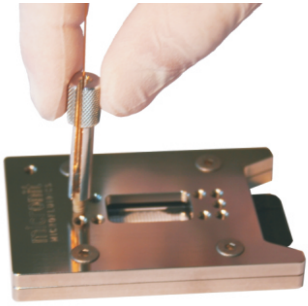

Figure 2.8. Using the extender tool for tightening the fittings

4. **Visual check**

A visual inspection of the ferrules can be performed, revealing if the ferrules properly fit inside the chip holes or onto the top surface of the chip and to confirm that the capillaries are aligned with the channels (Figure 2.9).

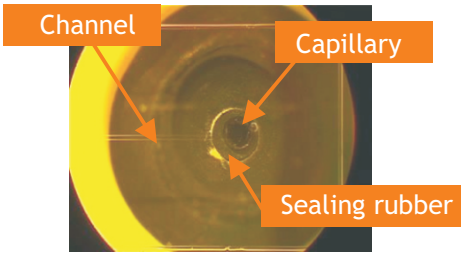

Figure 2.9. Capillary correctly positioned above the channel

When sealing with the conical side inside the hole (which is optional), the intensity of the colour of the seal will change by tightening the fittings. The reason for this is the increasing contact area between the sealing rubber and the sidewall of the hole.

2.4.2 STEP 4B - TEFLON OR STAINLESS STEEL CONNECTION KIT

Step 4B is specifically for the Teflon or the Stainless Steel Connection Kit.

1. **Assembling the fittings**

   The procedure is basically the same for stainless steel as for teflon tubing. It is advised to clean the chip holder before assembling, and in particular the fitting assembly hole (port no. 11). Particles can damage the ferrule. Before cleaning the chip holder, separate the top from the bottom part using the Allen key.

   For the assembly, slide the nut, steel compression ring and ferrule (in that order) onto the tubing. The flattened end of the ring should face towards the nut with the narrow end of the ferrule towards the ring (Figure 2.10). For the untrained eye it can be hard to determine which side is narrower, so double check if you are not sure. The metal ring should be pushed onto the ferrule, in that way ensuring concentricity of ferrule and ring (Figure 2.11).

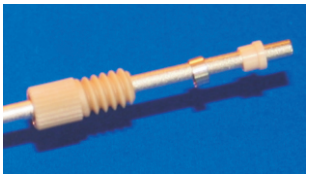

Figure 2.10. Fittings order

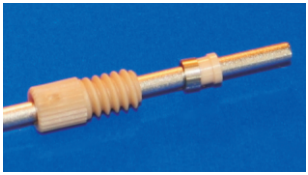

Figure 2.11. Ensure concentricity of compression ring and ferrule

   Press the tubing and ferrule to the bottom of the fitting assembly hole (port number 11) in the chip holder while tightening down the nut (Figure 2.12). Tighten comfortably finger-tight. You may use the extender tool to tighten some more, however be sure not to over tighten the ferrule.

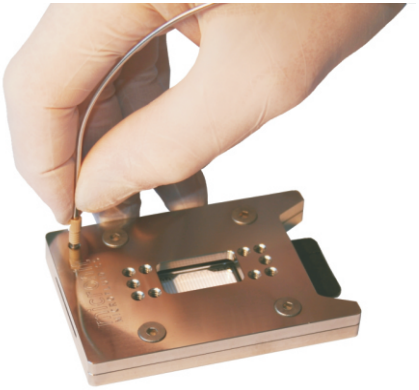

Figure 2.12. Threaded hole for the assembly of 'Flat-Bottom' fittings

2. **Ferrule assembly**

Check if the compression ring and ferrule are properly mated as shown in Figure 2.13.

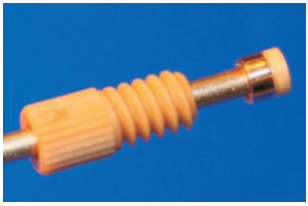

Figure 2.13. Proper assembly of compression ring and ferrule

3. **Making fluidic connections**

Tighten the fitting in the appropriate fluidic ports (see Table 2.1.) by using the extender tool as shown in Figure 2.14. No extreme force should be necessary.

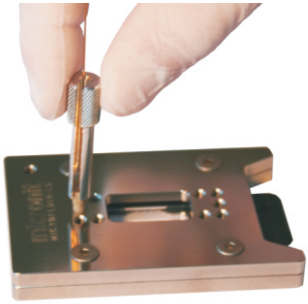

Figure 2.14. Tightening the connection

3 FRAME

The Fluidic Connect 4515 is supplied with the Fluidic Support. The support frame can be used for easy inspection of the chip from the bottom side. The chip holder can be placed upside down in the frame (Figure 3.1). Connect the tubing to any auxiliary equipment. The chip holder frame allows the tubing to be guided straight down or to the sides.

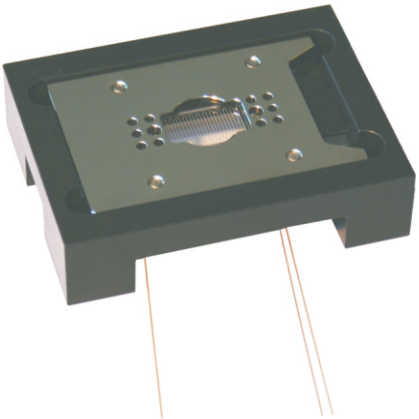

Figure 3.1. Chip holder upside down in the chip holder frame

4 QUESTIONS AND ANSWERS

This section answers frequently asked questions.

There are some air bubbles in the connection, how do I remove them?

To prevent air bubbles getting trapped between the connections, it can be helpful to put some DI water or a bit of the sample fluid in the holes of the chip before making the connections. When the sealing rubbers are placed, excess liquid will be pressed out of the holes. The connection will be bubble free.

There is no liquid flow.

If you are using low pressure pumps like membrane pumps, the pump may not have sufficient power to fill the system with water. It can help to place the fluid reservoir on a higher position, thus allowing both capillary action and gravity to help filling the system. Or try to fill the system with DI water before switching on the pump.

Otherwise check to make sure that the channel is not obstructed by debris or the Nanoport ferrules. The chips are clean room packed and free of debris, however there is always the risk that somewhere between the clean room and your experiment some particles found there way into the chip. Blocking with Nanoport ferrules is possible when the Nanoport ferrules are used with the conical side pressed in the chip hole and the fittings are tightened too much. Release the fittings slightly and check whether a flow is present.

The connection leaks during testing.

When the ferrules are not assembled straight onto the glass chip, there can be a leakage. Assemble the connections again, following the instruction of this manual.

The dead volume seems to increase.

When the bottom side of the sealing rubber is damaged, it will increase the dead volume in the connection. The area of contact between the sealing rubber and channel becomes smaller. Check the sealing rubbers and replace them if necessary.

The chips does not fit the chip holder.

Despite the checks at Micronit it is possible that a chip is slightly larger than specified. This is an exception. We can rework the chip to the right dimensions.

During my analysis the chip suddenly cracked, how is this possible?

The chip is made of glass, tiny cracks in glass can propagate during your tests when the glass is stressed. If this happens, the connections are most likely too tight. Especially with thin bottom chips this is more likely to occur.

How many times can I use a ferrule?

Both Nanoport and Flat-bottom ferrules can be used multiple times. There are some factors that can reduce the lifespan of the ferrules.

When using the Flat-bottom ferrules it is possible that the ferrule are tightened over the edge of the glass holes, which can damage the sealing area of the ferrule. After reusing the ferrule multiple times the damage can be cause leakage and replacing the ferrule is required. The damage should be visible to the naked eye.

The seal is created by elastic deformation of the ferrule. Too much tightening can cause plastic deformation, reducing the ability to create a functional seal.

When using Nanoport ferrules, the ferrules are sensitive to thermal cycles. Unloaded ferrules can withstand high temperatures up to 200°C, but when compressed to create the seal (applying pressure and torque on the material), temperatures above 50°C are not advised. Also long term experiments can result in chemical changes of the ferrule, reducing its function.

I can see fluid flowing in degassing lines, is the chip broken?

The glass chips contain so-called degassing channels; these are non-functional channels solely used for manufacturing purposes. When you see fluid in these degassing channels, this does not mean that the chip is broken. Normally there is no water in the degassing channels, but it is possible that during cleaning or after previous leakage, fluids flows in these degassing channels from the sides of the chip. When fluids are visible check the fluidic connections to see if there is no leakage from these fluidic connections.

Is it possible to place the chip holder in a bath with an elevated temperature?

The Fluidic connect has a maximum working temperature of 50-80C depending on the connection type used. The Nanoport ferrules (supplied with Fused Silica Connection Kit) can only be used up to 50°C when tightened. The materials used are all corrosion resistant and can be used under water. Note that when using Nanoport ferrules, there is a chance that the ferrules can leak due to softening (which is reversible) of the material when the initial tightening force was insufficient to compensate for this 'loss of physical properties'. The loss of physical properties also depends on the temperature, chemicals used and applied tightening force (torque). With increasing time at high temperature, chemical changes occur. These generally cause an increase in hardness, along with volume and compression set changes.

5 TIPS AND TRICKS FOR CONNECTION

Please read the tips and tricks before connecting Fluidic Connect 4515.

5.1 TIGHTENING FORCE

Why is the tightening of the connections specified?

1. To create a proper sealing between the ferrule and the chip, the ferrule must be pressed tight against the chip.
2. Once the seal is created, additional force enables a higher back pressure of the fluid, but the additional force needed for e.g. 100 bars, is relatively small. Tightening finger tight is estimated to be roughly 7cNm of torque.
3. Applying even more torque is unnecessary; it will only stress the chip, possibly breaking of the chip or permanently deforming the ferrule.

The manual says that I should tighten the connection finger tight, how do I know if the connection is finger tight?

Note that over tightening can break the glass chip, especially when working with a thin-bottom chip like the R50.332.3 or the X3550CH.3 chip. Use the following protocol to avoid breaking of microfluidic chips.

1. To tighten finger tight, you should twist the connection with the tip of your thumb and index finger, until you feel the ferrule pressing onto the chip (tightening resistance increase). You should not try to get a better grip on the connection, just proceed with step 2.
2. After finger tightening, tighten the nut with the extender tool:
   - another 1/4 round for Flat-Bottom connections (Teflon / Stainless Steel)
   - another 1/3 round for Nanoport connections (Fused Silica)

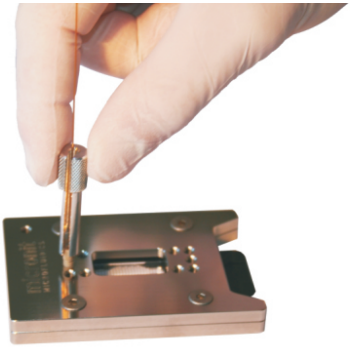

Figure 5.1. Extender tool, for 1/4 or 1/3 round additional tightening

5.2 STAINLESS STEEL / TEFLON CONNECTION KIT

The tips and tricks in this section are related to the Fluidic Connect in combination with the Stainless Steel or Teflon Connection Kit.

I connected all components according to the manual, but the connections still leak. What can be wrong?

1. Make sure the connections are finger tight (see 5.1. Tightening Force), if so DO NOT tighten the connections any further, it might break the chip.
2. Check if there is no tension on the tubing, causing the tubing to exert a force on the seal.
3. If the tubing exceeds the ferrule edge, this can cause the problem, see figure 5.2.

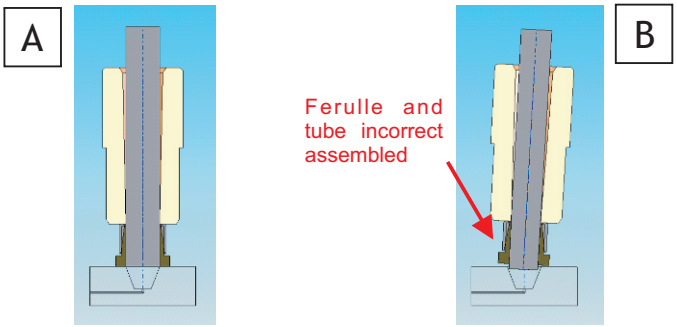

Figure 5.2. Assembly of tubing and ferrule

6 SPECIFICATIONS

6.1 FLUIDIC CONNECT 4515

Chip Holder

- Maximum pressure : 100 bar / 1450 psi (10 bar for thin bottom chips)
- Maximum working temperature : 50 °C (with Fused Silica Connection Kit)
  80 °C (with Teflon or Stainless Steel Connection Kit)
- Dimensions (l x w x h) : 80 x 55 x 9.5 mm
- Material holder : stainless steel 316

Inverter Frame

- Maximum working temperature : 80 °C
- Dimensions of frame (l x w x h) : 100 x 75 x 24 mm
- Material of frame : POM (Polyoxymethylene)

6.2 FLUIDIC CONNECTIONS

Fused Silica Connection Kit

- Dimensions capillaries : 360-375 µm OD, 150 µm ID
- Material nuts : PEEK (Polyether ether ketone)
- Material fittings : Perlast ™

Teflon Connection Kit

- Dimensions capillaries : 1/16" OD, 250 µm ID
- Material nuts : PEEK (Polyether ether ketone)
- Material fittings : PEEK (seals) / stainless steel (rings)

Stainless Steel Connection Kit

- Dimensions capillaries : 1/16" OD, 250 µm ID
- Material nuts : PEEK (Polyether ether ketone)
- Material fittings : PEEK (seals) / stainless steel (rings)

6.3 FLUIDIC SLIDE (CARTRIDGE AROUND CHIP)

- Maximum working temperature : 80 °C
- Material Fluidic Slide : PP (Polypropylene)

7 PART LIST

- **Chip holder (assembled)**
- **Inverter frame**
- **Allen key**
- **Extender tool**
- **2 Alignment nuts**
- **User Manual**

Please contact us if you have any questions or if you need help with your Fluidic Connect.

We wish you lots of succes with your microfluidic experiments!

FLUIDIC PRO

BRINGING YOUR MICROFLUIDIC DESIGNS TO LIFE

Let's say you have a great idea for a microfluidic chip but don't have the time or access to a cleanroom environment to fabricate it yourself. Then Fluidic PRO is the solution for you.

The Fluidic PRO prototyping service allows your microfluidic designs to be manufactured in a class 100 cleanroom by professionals. Fluidic PRO enables you to stay focussed on your research. It saves you time both in design and lab hours, speeds up your research, makes you more productive and allows you to publish sooner.

Fluidic PRO offers maximum freedom through a wide range of possibilities.

- Customized designs
- Glass or fused silica
- Wide range of channels depths and widths
- Thick- or thin-bottom chips, suitable for confocal microscopy
- Integrated electrodes
- Up to 4 different designs per batch
- Small batches starting with only 12 chips per batch

With 10 years of experience in microfluidic chip manufacturing for science and industry, Micronit is the perfect partner to outsource your microfluidic chip needs.

HOW TO PROCEED?

Make up to 4 different designs of desired channel layouts, based on the standard 10-hole pattern. Our design experts will transform them to CAD designs. We will send the designs back to you for a final check, and after your approval we will start processing. After 3 to 4 weeks, you will receive your chips and you can start your research.

Contact the Micronit sales team to discuss the possibilities and to receive a quotation. Call +31 53 850 6 850 or e-mail info@micronit.com