

Operation Manual

BUTTON CELL TEST FIXTURE KIT

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Button Cell Test Fixture Operation Manual



PARTS INCLUDED IN TEST KIT

Part Name	Description	Quantity
Button Cells	Cells included in the kit for testing.	5
Alloy-X Manifolds	Test manifolds.	2
Cell Seal	Seals for the cell, seals cell to manifold.	15
LNCCu air-side ink	Contact paste for the cathode, 50g pot.	1
NiNiO fuel-side ink	Contact paste for the anode, 50g pot.	1
Platinum wire	Voltage sensing wire.	1 m
Silver foam air current collector	Silver meshes, pre-cut and shaped.	5
Nickel foam fuel current collector	Nickel meshes, pre-cut and shaped.	5
Ceramic insulation	Insulation for voltage sense and current wires.	2 m
Braided silver wire	Current wire.	1 m
Alumina alignment pins	Alignment Pins.	4
Alumina felt isolation layer	Used to prevent shorting	12
Paste applicator mask	Used to apply contact paste and prevent port blockages.	1
Never-Seez Can	Anti-Seize used with bolts on current plate.	1 can
1/4"- 20 x 3/8" Bolts / Washers	Used to secure current wires to current plates.	10

REQUIRED TOOLS AND EQUIPMENT

Equipment	Description	Quantity
Furnace	Appropriately sized furnace capable of 1000 °C maximum temperature.	1
Compression system	Used to compress seals.	1
Fuel humidifier (optional) and condensate collection.	Used to predict OCV, collection of condensate to prevent blockages of exhaust.	1
Electronic load controller and DAQ	Used to obtain and collect performance data.	1
Potentiostat/galvanostat (optional)	Used to collect impedance data for in-depth study of electrode characteristics and resistances.	1
Gas controls	Used to control fuel and air gas compositions. 1 SLPM or lower maximum flow recommended.	1
Furnace furniture and insulation	Used to properly position cells and manifolds, insulate gas and current pass-throughs.	N/A

INTRODUCTION

The purpose of this operating manual is to provide, in detail, the steps required to prepare, assemble and test button cells. There are several auxiliary pieces of equipment that are needed to successfully test that are not included with this kit, listed in the “Required Tools and Equipment” table on the previous page. This manual will make some assumptions on what that equipment is capable of, and how it will interface with the test kit.

Please contact us if there are any unique setups or configurations that need to be considered before purchasing the testing kit.

The seals included in this kit must be compressed to seal effectively. The recommended amount of compression for the Button Cell Test Kit is 15lbf and 25 lbf (66 N and 111 N) of compressive force for 20mm and 25mm cells, respectively, evenly applied to the faces of the manifolds. Common methods to apply this force are:

- Use blocks of high temperature steel as weights.
- Pneumatic or hydraulic cylinders.
- Screw or lever clamping systems.

The use of a condensate collection system is recommended. This will prevent blockages in exhaust plumbing, and allows for measurement of water generation rate, which could assist in data analysis.

The manifolds are supplied without fittings, and with long straight tubes attached. This is to allow the user to choose fittings that will be compatible with their gas and exhaust infrastructure. The long tubes allow the user to bend or cut as needed to fit test furnaces and interface with gas controls.

SAFETY PRECAUTIONS

There are no intrinsic hazards associated with the Button Cell test kit. However, safe operation of the kit requires the user to consider multiple sources of potential danger. There are three major hazards when operating the test kit.

- Explosive, flammable and toxic gases – Be sure to connect exhaust lines to appropriate ventilation. Use flammable gases only in concentrations outside their flammability or explosion limits unless there are appropriate measures in place to protect against explosion. The manifold set is NOT shipped in an oxygen clean state, use in pure oxygen is not recommended.
- Electrical shock – The manifold itself is energized while testing. Use appropriate insulation and connections outside the furnace to prevent shorting. Ensure that the test kit does not contact the heating elements of the test furnace. This can energize the manifold and present a shock hazard.
- Hot surfaces – The furnace and any tubing or wires within will become extremely hot during operation. Use insulation, PPE and guarding to prevent burns.

ASSEMBLY AND LOADING INSTRUCTIONS


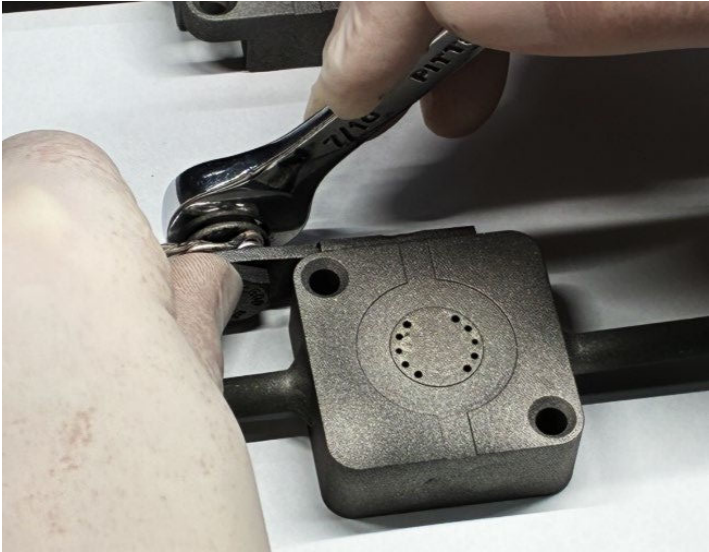
Before Testing:

- Before building a cell in the test fixture, test fit the manifolds in your furnace to see what bends, if any are required for tubing, and where the voltage sense and current wires will exit. Choose what fittings and electrical connections you will use to control gas composition and collect data.
- The manifolds do not require any heat-treatment or conditioning prior to first use.
- You may use cyanoacrylate glue on the seals during assembly to prevent movement.

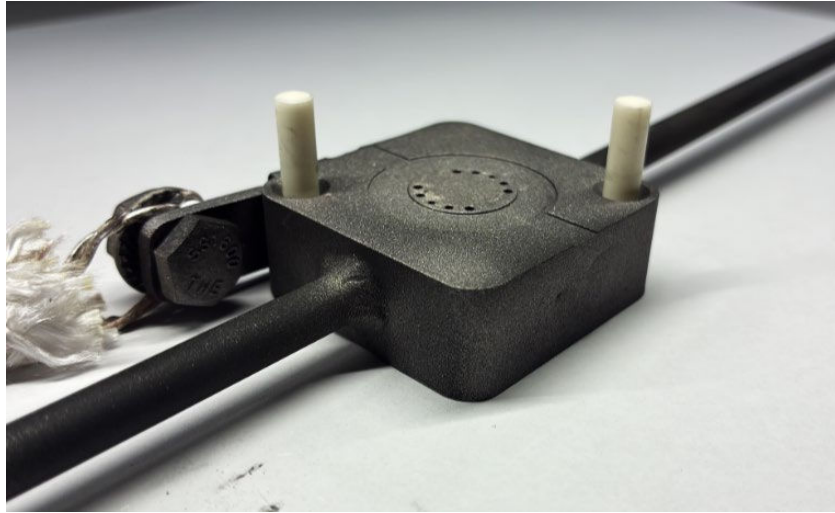
After Testing:

- It is recommended that between tests, all surfaces of the manifolds and current tabs are sandblasted.
- Especially important are the seal areas, and the current tab where the silver current wire makes contact.

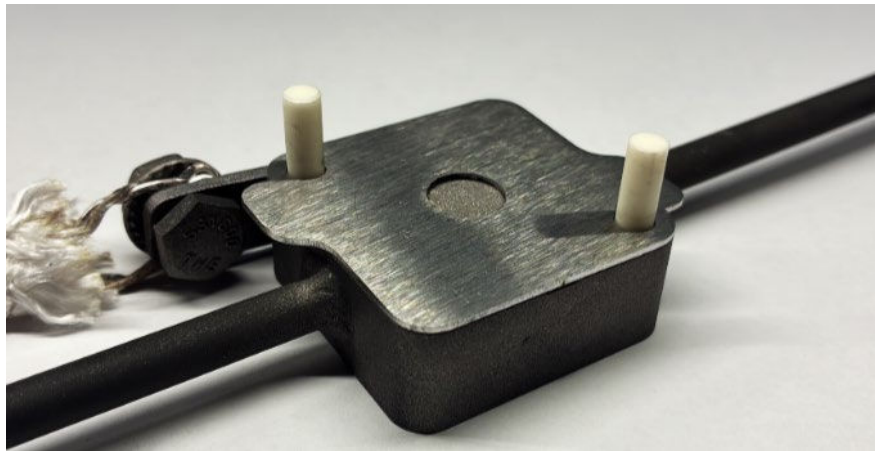
Cell Assembly:

Step	Description
<p>1. Set fuel manifold on flat, stable surface.</p>	
<p>2. Attach silver wires to both manifolds.</p>	<ul style="list-style-type: none">• Apply anti-seize to the bolts before you tighten the silver wire to the current tabs. 

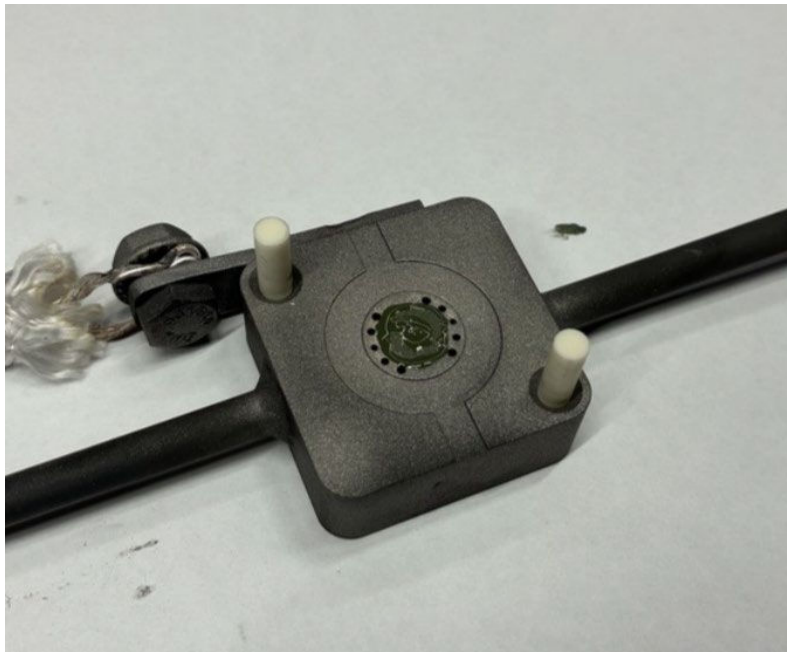
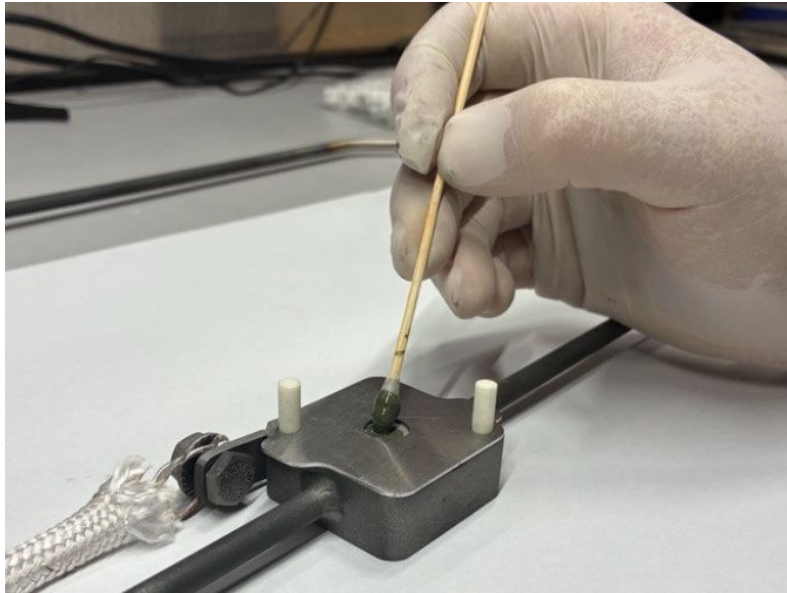
3. Insert alumina alignment pins into fuel manifold.



4. Place the paste applicator mask on the alignment pins.



- 5. Apply a thin layer of NiNiO contact paste.**

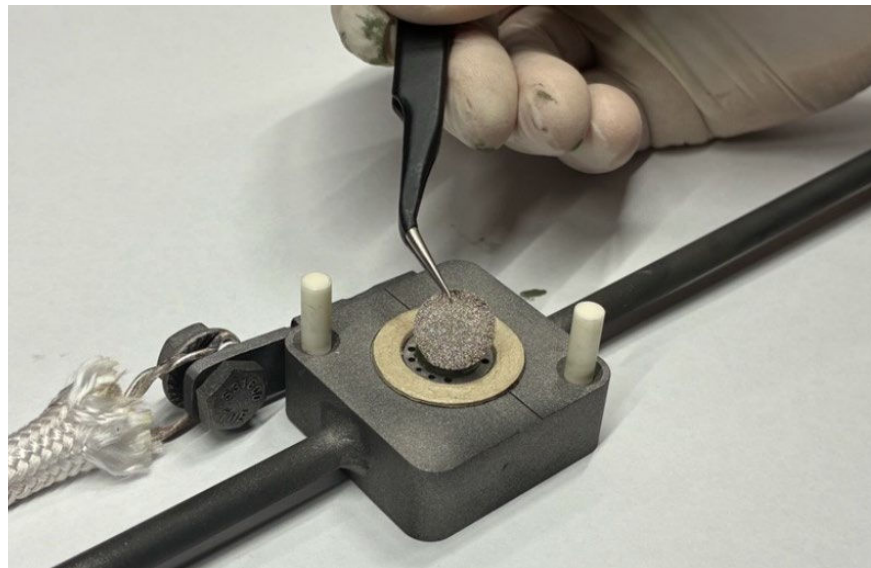


6. Place a seal on the fuel manifold

- You may use cyanoacrylate on the seal on this step.



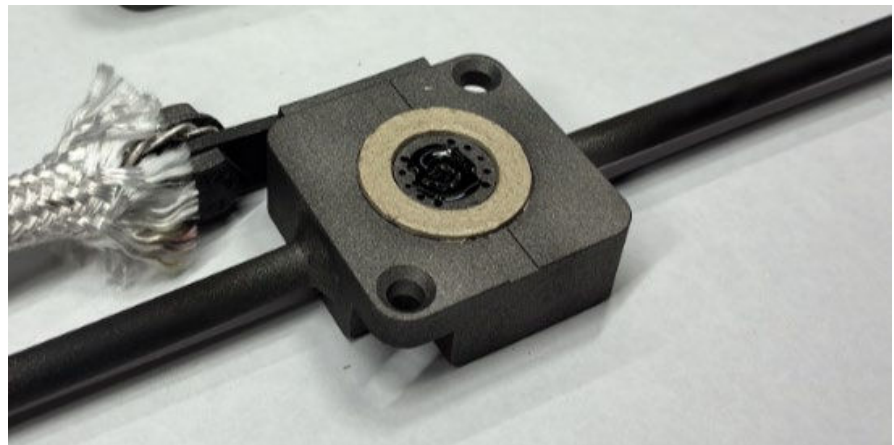
**7. Place the fuel
current collector
foam**



8. Paint air manifold using spare alignment pins and clean applicator mask.

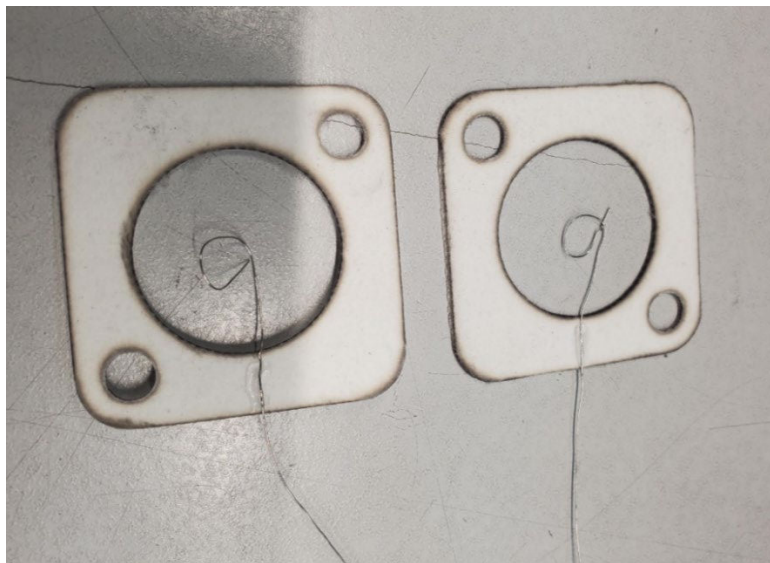
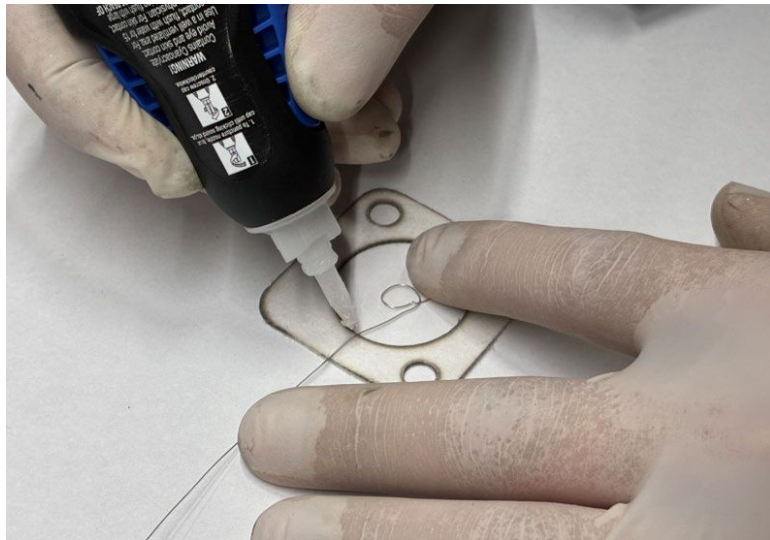


9. Place air cell seal using cyanoacrylate glue to prevent movement.



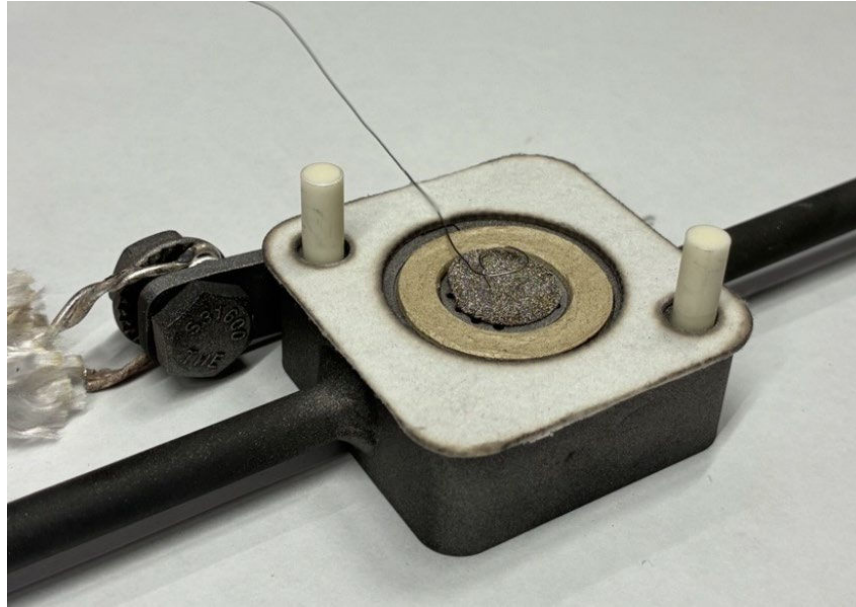
**10. Prepare voltage
sense wires and
alumina isolation
layers.**

- You should apply cyanoacrylate between the wire and felt on this step. This prevents the sense wire from moving during assembly.
- Note the hole alignment of the alumina layers while applying adhesive.

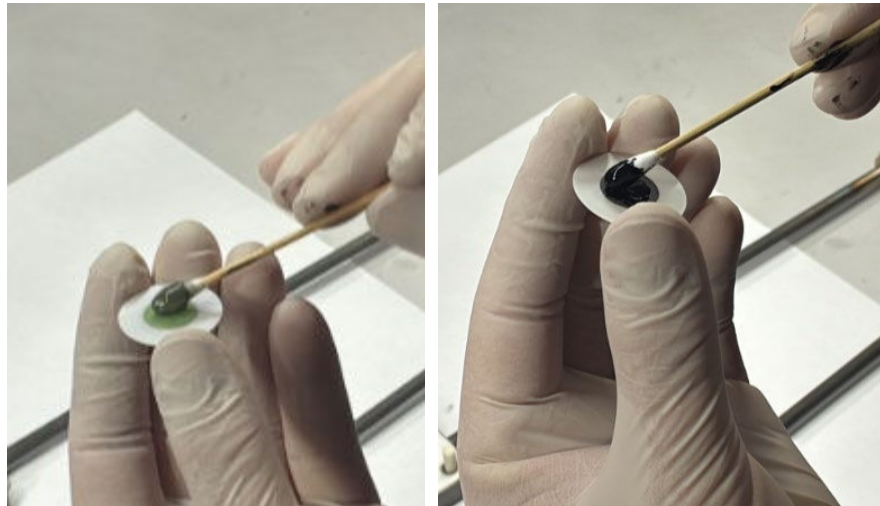


**11. Place the voltage sense wire/
alumina isolation
layer.**

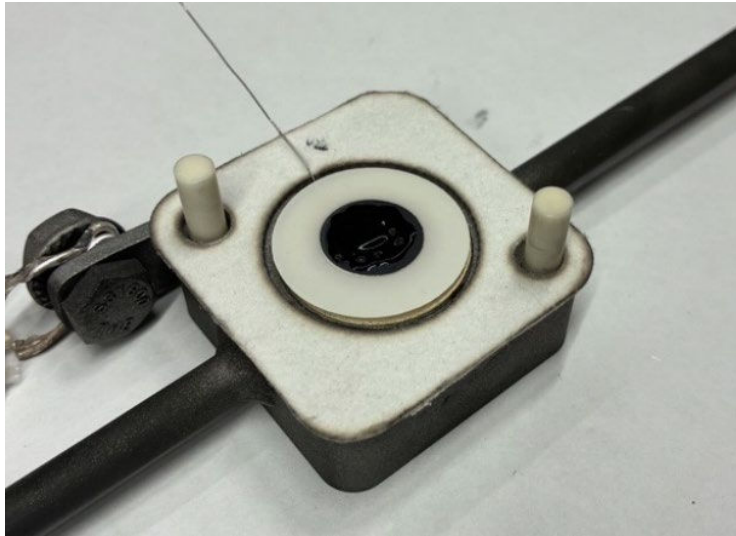
- Ensure the sense wire is facing upwards, and not touching the manifold face.



**12. Paint fuel and air
electrodes with a
small amount of
NiNiO and LNCCu
contact paste,
respectively.**

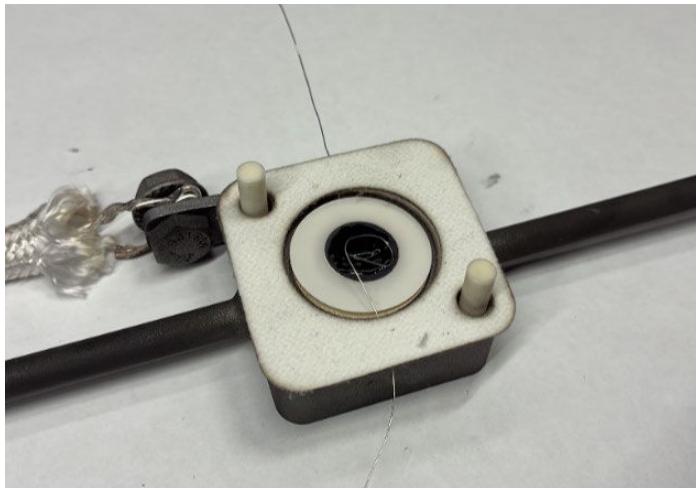


**13. Place the cell, fuel
electrode face
down.**



**14. Place the second
alumina isolation
layer over the
alignment pins.**

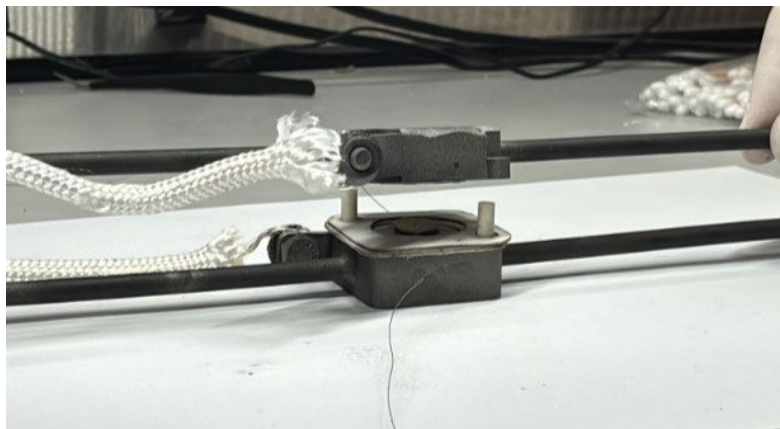
- Ensure the sense wire is facing downwards, and not touching the manifold face.



**15. Place the air
current collector**



**16. Place the air
manifold onto the
fuel manifold**



17. Transfer to furnace

- Hold assembly lightly together during transfer.
- Lift assembly by the tubing.

18. Apply compression

- Apply 25 lbf (111N) to the assembly for 25mm cells, and 15lbf (66N) for 20mm cells.

19. Connect gas lines, voltage sense and current wires.

- Attach the gas inlets to your gas control system. Connect exhaust lines. Connect the voltage sense wires and **only** the fuel-side current lead to your electronic load.
- Feed the voltage sense wires through an appropriate length of CerSleev ceramic insulation to help isolate them. This is best accomplished by attaching the end of the wire to a thin and rigid object, like a pencil or crochet hook, and feeding it through the tube.
- Insulate all openings to furnace, taking care to prevent shorts between the sense wires or current wires.
- **You can check for continuity between the voltage sense wires or current wires while the furnace is cool to check for shorts.**
- The system is now ready for cell conditioning

CELL CONDITIONING

Before heating up the test assembly, check that the air-side current wire is **not connected** to the electronic load. Follow the recipe below to heat-up, condition and reduce the cell. Conditioning is considered the heating of the cell with nitrogen on the anode, and air on the cathode. Reduction begins once the furnace has reached 850 °C, and the hydrogen concentration slowly begins to increase. **The recommended ramp rate for this kit is 2°C/min.**

Cell Conditioning / Reduction					
Furnace and Dwell Times			Oxygen Electrode	Fuel Electrode	
Step	Time [hh:mm:ss]	Temperature [°C]	Air Flow [SLPM]	Nitrogen Flow [SLPM]	Hydrogen Flow [SLPM]
1	7:00:00	0 → 850	0.100	0.100	0.000
2	0:30:00	850	0.200	0.100	0.000
3	0:30:00	850	0.200	0.075	0.025
4	0:30:00	850	0.200	0.050	0.050
5	0:30:00	850	0.200	0.025	0.075
6	2:30:00	850	0.200	0.000	0.100

The cell is considered fully reduced when the OCV has stabilized at or above 1.2V. This may take longer for ASCs. The cell is now ready for testing, and you may connect the cathode current wire to the electronic load.