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Instructions for Loading Single Cell with 28 cm^2 active area

Included in 28 cm^2 Test Manifold Kit

- ☐ One pair 28 cm^2 manifolds
- ☐ Five 28 cm^2 NextCells
- ☐ Ten seals cut to 28 cm^2 test kit specification
- ☐ 50 grams of LSM cathode ink
- ☐ 50 grams of nickel metal anode ink
- ☐ 36 inches of 0.008 inch (0.2 mm) thick platinum wire
- ☐ Three pieces of 28 cm^2 platinum wire
- ☐ Five pieces of 28 cm^2 nickel foam
- ☐ One copy of Instructions
- ☐ One tube of superglue
- ☐ One pair of insulating ceramic cloth tubes

Required tools and Equipment

- ☐ One furnace with a maximum temperature of 1000°C
- ☐ Compression system
- ☐ Anode humidity and condensation collection systems
- ☐ Electronic load
- ☐ AC Impedance Spectroscopy (optional)
- ☐ Gas control
- ☐ Kiln furniture and insulation

Introduction

Below are step by step instructions on proper assembly of the 28 cm^2 Test Manifold Kit for testing.

The seals in the test kit are compression seals; therefore a compression system must be used to get accurate results. This can be done a number of different ways; the two most common are the use of furnace lid to apply a compressive force or to apply a series of weights (e.g. blocks of high temperature steel) onto the top of the manifold. Both methods will give you the compression needed to have the seals work properly. Careful preparation of the furnace and insulation is absolutely critical to loading the test fixture without damaging the cell. The instructions below assume a split-tube furnace is used, though they do not give explicit preparation instructions. Adjust your methodology accordingly to your own furnace.

Also an anode humidity system is recommended to make the hydrogen gas less aggressive towards the fuel cell. The anode humidity system is used during testing and not during the furnace start up. The humidity system can be simple, such as an in-line air tight vessel half full of water with a gas inlet tube submerged in the water and the outlet tube above the water. Or you can use membrane humidifiers, bypass systems, etc. Also recommended is an anode outlet condenser to measure water generated during your experiments.

Cell Loading

1. Place small drops of a cyanoacrylate “superglue” on corners of both manifold and place seals on each. (Figure 1 & 2)

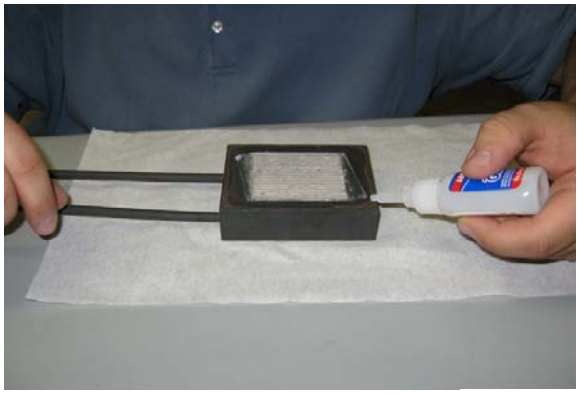

Figure 1

Figure 2

2. Apply 10-12 drops of aluminum oxide liquid evenly to each of the seals
    - Make certain to apply seals to both manifolds before moving to Step 3

   (Figure 3)

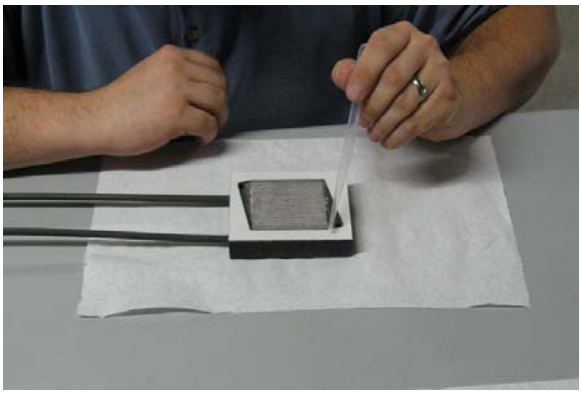

Figure 3

3. Paint active area of anode manifold with Ni metal ink
    - Use the ink sparingly to prevent clogging the gas flow channels

   (Figure 4)

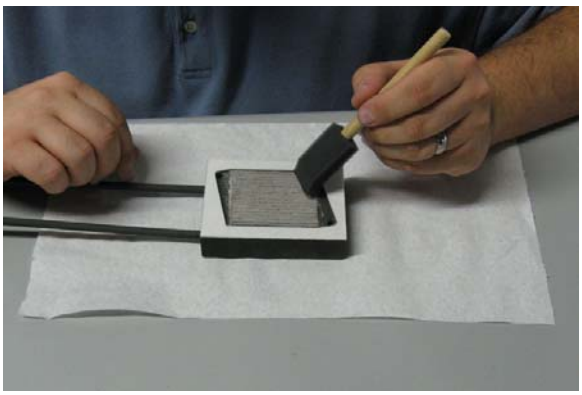

Figure 4

4. Trim Ni mesh to assure fit within the seal

5. Place Ni mesh on active area of anode manifold and lightly press into place (Figure 5)

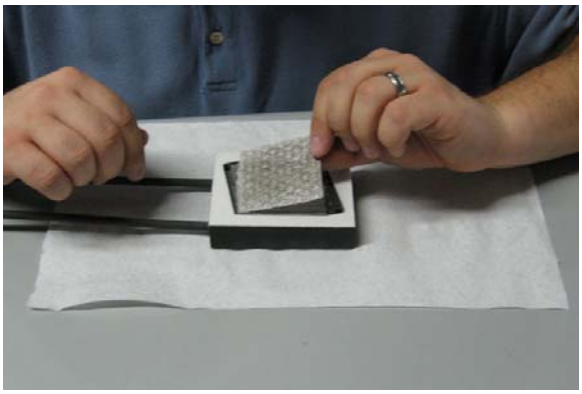

Figure 5

6. Bend small hook into platinum voltage wire and place in the middle of the Ni mesh on the anode manifold (Figure 6)

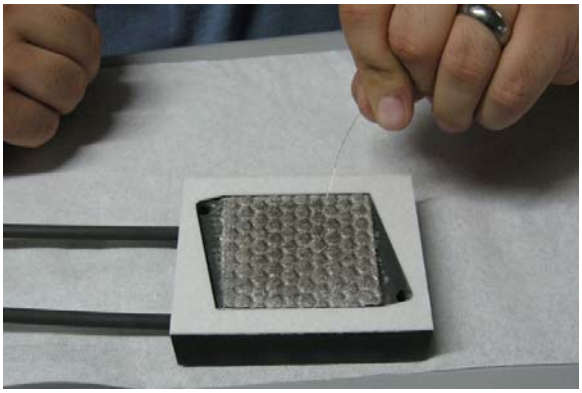

Figure 6

7. Evenly paint active area of cell with Ni metal ink (Figure 7)

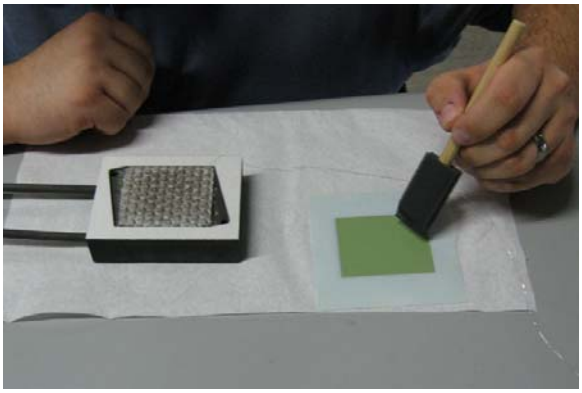

Figure 7

8. Carefully align the anode side cell against the Ni mesh and wire in place on the anode manifold
(Figure 8)

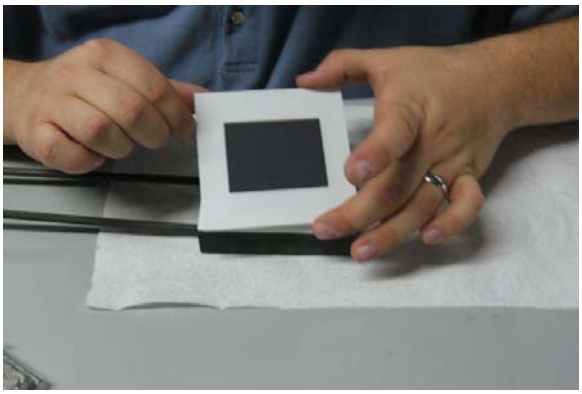

Figure 8

9. Check the size of the Pt meshes against the seal on the cathode manifold to assure no overlap and good fit within active area
    - Trim if necessary

10. Lightly holding the cell in place, paint the cathode active area of the cell with cathode ink
(Figure 9)

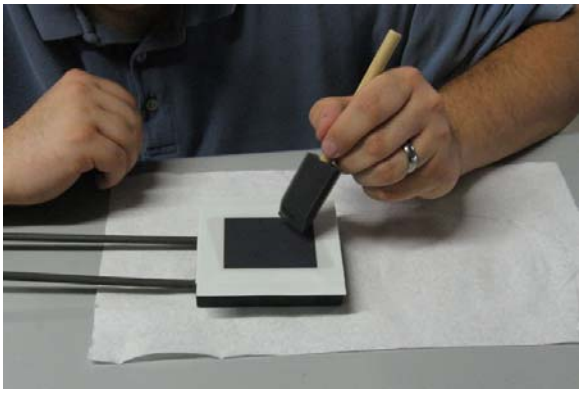

Figure 9

11. Bend small hook into platinum second voltage wire and place in the middle of the painted cathode active area
(Figure 10)

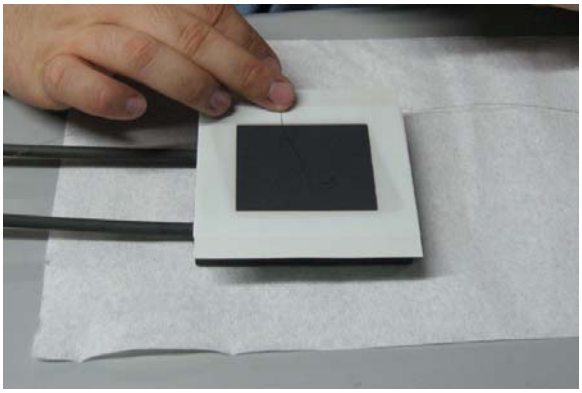

Figure 10

12. Place the Pt mesh onto the cathode active area and lightly press into place (Figure 11)

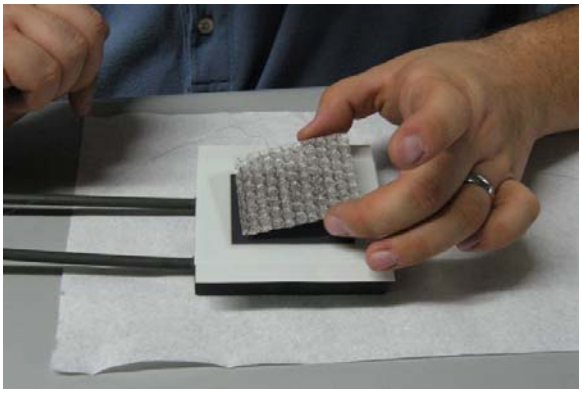

Figure 11

13. Carefully holding the cell in place again, paint over the Pt mesh with cathode ink (Figure 12)

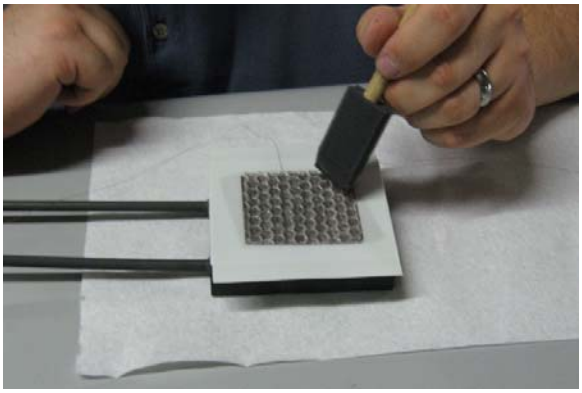

Figure 12

14. Place the anode manifold with cell into the furnace.
(Figure 13)

Figure 13

15. Place insulation atop the anode tubes that will separate them from the cathode tubes.
(Figure 14)

Figure 14

16. Make appropriate anode gas inlet and outlet tube and current cable connections.
(Figure 15)

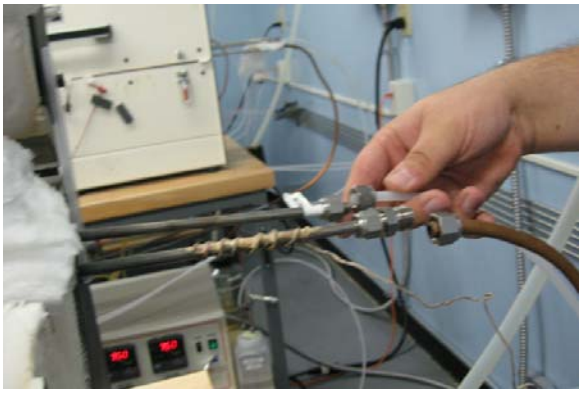

Figure 15

17. Place insulating ceramic cloth tubes over anode and cathode voltage taps to isolate from the furnace and one another
(Figure 16)

Figure 16

18. Connect anode and cathode voltage taps to appropriate clips and secure in place to prevent pulling or otherwise stressing the connections
(Figure 17)

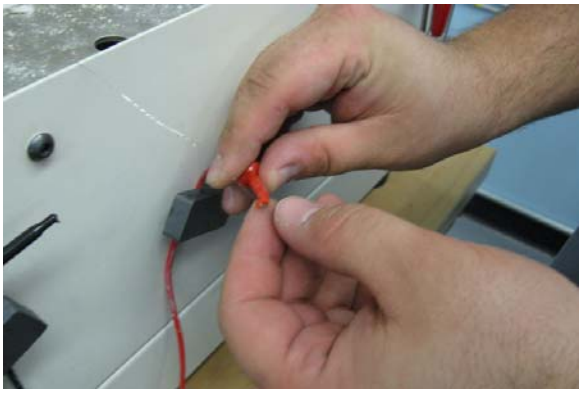

Figure 17

19. Carefully place cathode manifold with alumina seal in place on the cell making note to align active areas as much as possible
(Figure 18)

Figure 18

20. Place remaining insulation in place at furnace opening and on top of cathode manifold
(Figure 19)

Figure 19

21. Slowly and carefully lower furnace lid applying pressure to manifold/cell component
    - Note, if using a weight system, apply weight before closing furnace

    (Figure 20)

Figure 20

22. Lightly touch the cathode inlet and outlet tubes to check for good compression from furnace lid
    (Figure 21)

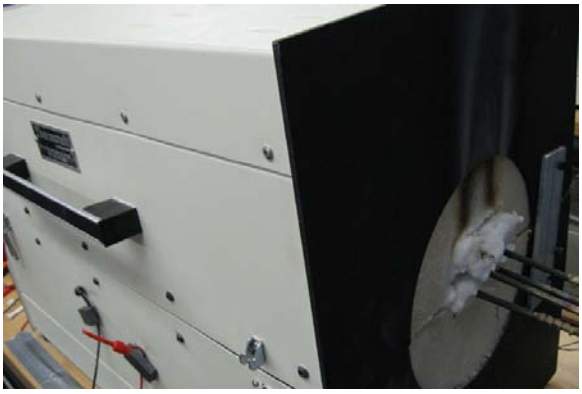

Figure 21

23. Make appropriate cathode gas inlet and outlet tube and current cable connections.

24. The set up is now complete.

Cell Conditioning

1. Unplug the cathode current cable from control box and turn load box component off to assure no current is passing through the system during heat-up

2. Program furnace to heat up to 850°C in 14 hours (~1°C/min) and hold at 850°C

3. Increase anode and cathode flow to appropriate desired flowrates for heat-up
    - Cathode: air @ 350 sccm (ml/min)
    - Anode: dry N_2 @ 350 sccm

4. Start furnace program

5. Allow cell and furnace to heat overnight

Cell Reduction

1. Switch on load box component of control box and record Open Circuit Voltage (OCV)

2. You may wish to disconnect anode and cathode gas outlets to expose and clean binder that may have condensed in the metal outlet tubes

3. Connect the anode outlet tube to the anode gas humidity condenser (if desired)

4. Connect anode humidity. If using a bypass valve system, turn the valve towards the humidity bottle. If using manual connections, place humidification vessel into the line.

5. Maintaining 350 sccm N_2 on the anode, increase the H_2 flow to 50 sccm

6. Increase cathode air flow to 500 sccm

7. Allow system to sit for 20-30 minutes or until OCV begins to stabilize, whichever is longer

8. Increase the H_2 to 100 sccm and allow to sit for another 10 minutes

9. Transition the anode feedstream to 300-450 sccm H_2 and 0 sccm N_2 in 50 sccm increments allowing the cell to sit at each condition for 5-10 minutes (or until the OCV begins to stabilize, whichever is longer)

10. Concurrently transition the air flow up to 1000-1500 sccm in even increments

11.
12. Once at the desired gas flows of 300-450 sccm H_2 and 0 sccm N_2 on the anode and 1000-1500 sccm air on the cathode, allow system to sit for 15 minutes to assure steady state

13. Connect cathode current cable at the control box

SOFC Manifold/Fixture is ready for testing