



|     | Function  |   | Operating Conditions   |         |
|-----|---|---|--|---------|
|     |   |   | Condition  | Time    |
| 101 | Cut membrane                                      |   | Size of active area, designated by customer  | ~10min  |
| 102 | Soak in H <sub>2</sub> O                          |   | 80°C   | 1hr     |
| 103 | Soak in H <sub>2</sub> O <sub>2</sub>             |   | 80°C   | 1hr     |
| 104 | Soak in H <sub>2</sub> SO <sub>4</sub>            |   | 80°C   | 1hr     |
| 105 | Rinse in H <sub>2</sub> O                         |   | 80°C   | 1hr     |
| 106 | Re-rinse in H <sub>2</sub> O                      |   | 80°C   | 1hr     |
| 107 | Re-re-rinse in H <sub>2</sub> O                   |   | 80°C   | 1hr     |
| 201 | Cut anode GDL                                     |   | Size of active area  | ~10min  |
| 202 | Soak anode GDL in H <sub>2</sub> O <sub>2</sub>   |   | 80°C   | 1hr     |
| 203 | Soak anode GDL in H <sub>2</sub> O                |   | 80°C   | 1hr     |
| 204 | Stabilize anode GDL                               |   | Secure with tape to paper  | ~1min   |
| 205 | A   | Mix anode catalyst solution, including binder                     | Composition dependent upon customer requirements   | ~30 min |
|     | B   | Place cartridge containing anode cathode solution into printer    | Composition dependent upon customer requirements   | ~1min   |
| 206 | Apply catalyst                                    |   |  | -       |
| 301 | Cut cathode GDL                                   |   | Size of active area, designated by customer  | ~10min  |
| 302 | Soak cathode GDL in H <sub>2</sub> O <sub>2</sub> |   | 80°C   | 1hr     |
| 303 | Soak cathode GDL in H <sub>2</sub> O              |   | 80°C   | 1hr     |
| 304 | Stabilize anode GDL (taping to paper)             |   | Secure with tape to paper  | ~1min   |
| 305 | A   | Mix cathode catalyst solution, including binder                   | Composition dependent upon customer requirements   | ~30min  |
|     | B   | Place cartridge containing cathode catalyst solution into printer | Composition dependent upon customer requirements   | ~1min   |
| 306 | Apply catalyst                                    |   |  |         |
| 401 | Hot Press   |   | 441 psi, and heat until temperature reaches 127°C, then turn off heat and cool to at least 38°C before releasing pressure. | -       |

The batch process flow diagram (BPFDF) shown above is representative of the entire process of making an MEA assembly. The process has been proven, and the only step that is being changed through our analysis is 206 and 306 (shown on the diagram in blue). These blocks represent the application method of the catalyst solution. Times have been listed for each of the batch process steps.

In the case of business plan A, in which a small weekend company produces membranes and sells them, the block 205 and 305 would represent mixing the catalyst solutions with the specifications of the customer, and then using our printing apparatus to print the catalyst solution onto the membrane. Our small business would perform each of the steps in the diagram and the customer would receive a complete MEA. For business plan B, producing cartridges, we would supply the customer with a cartridge with a catalyst solution of their specifications. The customer would perform the rest of the steps in the BPFDF on their own to produce an MEA.