

CONTENTS

CHAPTER 1	1
1.1. Background	1
1.2. Application of Direct Methanol Fuel Cell.....	2
1.3. Issues of Direct Methanol Fuel Cell.....	3
<i>1.3.1. Methanol Crossover</i>	<i>3</i>
<i>1.3.2. Carbon Dioxide Bubble</i>	<i>3</i>
<i>1.3.3. Flooding.....</i>	<i>4</i>
1.4. Literature Survey.....	5
1.5. Operation range for experimental parameters	8
<i>1.5.1 Contact Pressure.....</i>	<i>8</i>
<i>1.5.2 Temperature.....</i>	<i>9</i>
<i>1.5.3 Methanol Concentration</i>	<i>9</i>
<i>1.5.4 Methanol and Air Flow Rate.....</i>	<i>10</i>
1.6. Objectives.....	10
CHAPTER 2.....	19
2.1 Principle of Operation	19
2.2 Efficiency of Operation.....	19
2.3 Structure of Direct Methanol Fuel Cell.....	20
<i>2.3.1 Membrane Electrode Assembly (MEA)</i>	<i>20</i>
<i>2.3.2 Gas Diffusion Layer (GDL)</i>	<i>20</i>
<i>2.3.3 Bipolar Plate (BP)</i>	<i>21</i>
2.4 Capillary Driving Force	21

2.4.1 <i>Young's Law</i>	21
2.4.2 <i>Capillary Force</i>	21
CHAPTER 3	25
3.1 Design of Single Micro-DMFC	25
3.2 Design of Flow Field	25
3.3 Experimental Method and Apparatus	27
3.3.1 <i>Apparatus</i>	27
3.3.2 <i>Experimental Method</i>	27
CHAPTER 4	33
4.1 Preliminary Tests on Stainless Steel Channels	33
4.2 Integration of Single DMFC	34
4.2.1 <i>In-situ Visualization of Cathode side of DMFC</i>	34
4.2.2 <i>Performance Tests of DMFC</i>	36
CHAPTER 5	45
5.1 Conclusion	45
5.2 Future Work	46
References	47

List of Figures

Fig. 1-1 Transport processes in hydrophobic GDL. [4]	13
Fig. 1-2 Schematic illustration of serpentine configuration of n parallel gas channels in a PEFC. [5]	13
Fig. 1-3 shows a schematic diagram of the cathode separator with the water absorption layer and the waste channel. [7]	14
Fig. 1-4 (a) Z-type and (b) U-type parallel-channel flow configurations. [8]	15
Fig. 1-5 (a) Calculation of velocity values of the flow [11]	16
Fig. 1-5 (b) Visualization images [9]	16
Fig. 1-6 Schematic illustration of (a) pin-type flow field, (b) series-parallel flow field, (c) serpentine flow field, (d) integrated flow field, (e) interdigitated flow field, and (f) flow field designs made from metal sheets [10]	17
Fig. 1-7 Schematic illustration of multi-sectional cathode flow field [19]	18
Fig. 1-8 Shape of liquid film for hydrophobic silicon chip [19]	18
Fig. 2-1 Schematic diagram of the DMFC single cell with solid polymer electrolyte [20]	23
Fig. 2-2 Schematic diagram of the DMFC structure	23
Fig. 2-3 Schematic diagram of (a) carbon paper [21]	24
Fig. 2-3 (b) carbon clothes [21]	24
Fig. 2-4 configuration of a micro channel	24
Fig. 3-1 Schematic of the anode meshed collector	29
Fig. 3-2 Schematic of the single micro-DMFC	29
Fig. 3-3(a) Schematic of the anode acrylic plate	30
Fig. 3-3(b) Dimensions of the anode acrylic plate	30

Fig. 3-4(a) Schematic of the cathode acrylic plate	30
Fig. 3-4(b) Dimensions of the cathode acrylic plate.....	30
Fig. 3-5 (a) Schematic of the stainless steel multi-section flow field.....	31
Fig. 3-5(b) Dimensions of the stainless steel multi-section flow.....	31
Fig. 3-6 Calibration curve of micro rotameter	31
Fig. 3-7 Experimental equipment setup for multi-section parallel channels	32
Fig. 4-1 Dynamic process of SS flow flied plate with two hydrophilic glasses.	38
Fig. 4-2 Schematic of the integration of single fuel cell.....	38
Fig. 4-3 Schematic of vapor condensation on hydrophilic glasses in multi-channels.	39
Fig. 4-4 Dynamic process of water droplets in a gas channel and accumulations of droplet on hydrophilic glasses	39
Fig. 4-5a Schematic of formation of the droplets	40
Fig. 4-5b Schematic of water film formation.....	40
Fig. 4-6 shows the water condensation process with gold-plated surface	41
Fig. 4-7 Schematic of the flow field with gold-plated surface	42
Fig. 4-8 Comparison of stainless steel channels and gold-plated stainless steel channels.....	42

List of Tables

Table 1-1 Different Types of Fuel Cells [1]	12
Table 1-2 Characteristics of different types of bipolar plates [16]	12

