Three Dimensional Modeling of PEM Fuel Cells with Current Collection From the Gas Diffusion Layer

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Abstract

Proton exchange membrane fuel cells (PEMFCs) is the promising technology for mobile applications. One of the key component of fuel cells is the flow field plate through which hydrogen fuel will reach the anode and oxygen reach the cathode. Another function of the flow field plate is the electron collection. Traditionally flow field plates are made of graphite which makes them good for current collection. But with the development of miniature fuel cells, authors have reported flow field plates in silicon and other technologies such as PCB. As silicon is not a good electrical conductor, electrical contacts has to be attached to the Gas Diffusion Layer (GDL) for taking the power to outside world. This is achieved by attaching segmented contacts to the GDL area which are not covered by flow plates. Here we build a three dimensional model for a fuel cell in which current collection is carried out by segmented contacts attached to the GDL using COMSOL Multiphysics. The number of contacts and distance between the contacts were optimized. PEM FC Model suing COMSOL: Figure 1 shows the schematic of the PEM fuel cell modeled using COMSOL Multiphysics. Eight different ways of connecting contacts to GDL is analyzed in the current study.3-D models for all the eight schemes were also developed. L is the length of the cell. The width and height of all the contacts remain the same. Figure 1 shows the structure of the model with nine contacts on the anode side and one contact in the cathode side. 8 cases of current collection were analysed as shown in figure 2. From figure 3 it is clear that the performance of the cell gets degraded when segmented contacts are used. The effects are prominent in middle and high current ranges. The cell in case 3 having largest contact length has poor performance while the cell in case 8 having smaller contact length has performed better. This shows that the distribution of contact is more important than the length of the contact. Not much difference is observed in case of cells in case of 6,7,8,9 and 10 which shows that there exist critical number and length of contact above which the performance is independent. A 3-dimensional model for PEM fuel cell is validated under the experimentally feasible assumptions. The effect of segmented contacts on the fuel cell performance is studied by considering eight different cases employing different distributions and dimensions. The gaps between the contacts reduce the local over potential in the electrode reducing the local current density. Reducing the gaps by segmentation reduce this effect. It is also observed that the dimension of the contacts are not playing a big role in fuel cell performance while the distribution of contacts across the GDL has a significant impact in fuel cell performance.

Reference

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Figures used in the abstract

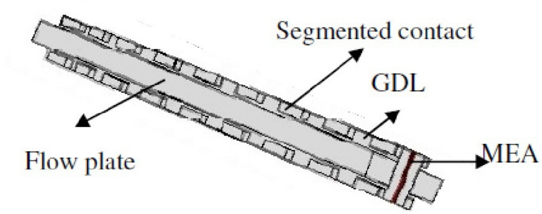

Figure 1

Case	No of contacts (anode side)	Total Length of contact (anode side)	No of contacts (anode side)	Total Length of contact (anode side)
1	3	0.66 L	3	0.66 L
3	4	0.5 L	4	0.5 L
4	5	0.625 L	5	0.625 L
6	5	0.625 L	1	L
7	8	0.5 L	1	L
8	9	0.41 L	1	L
9	8	0.4 L	1	L
10	9	0.375 L	1	L

Figure 2

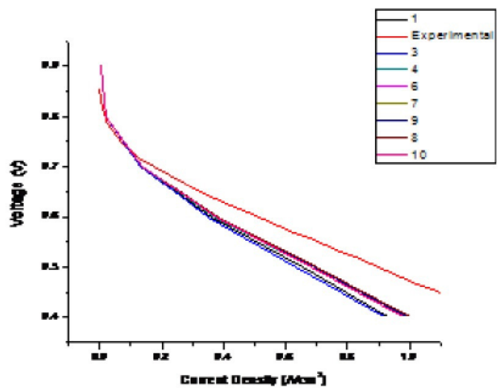

Figure 3