

Electrical Contact Resistance between GDL and Bipolar plate in a PEM Fuel Cell

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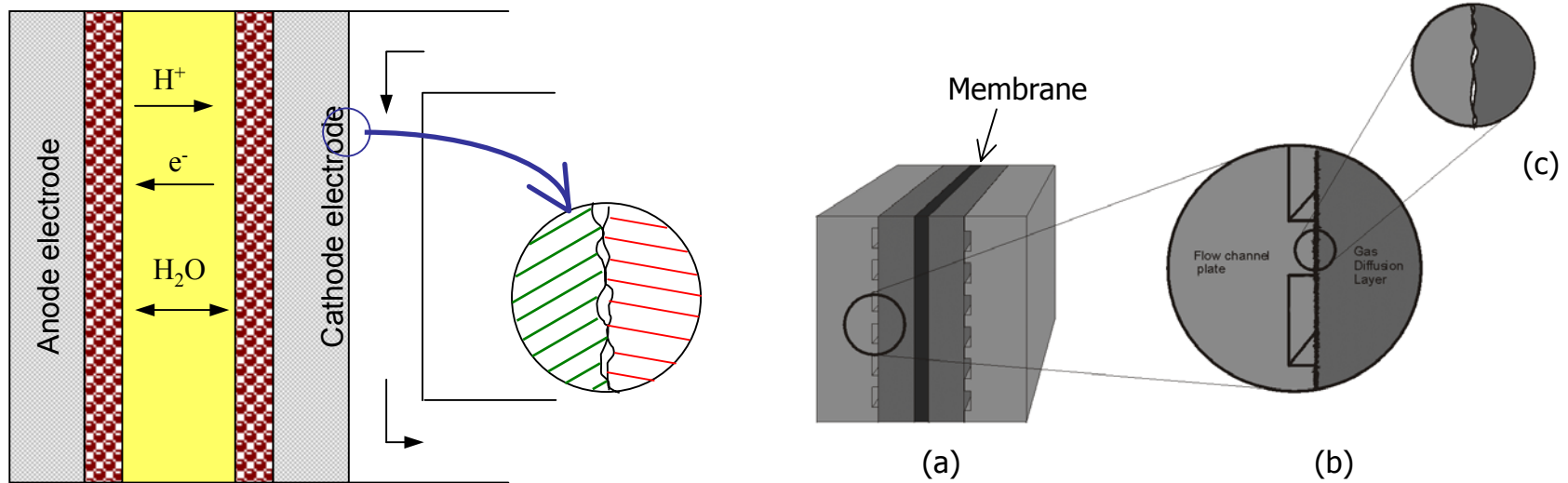
Outline

Objective: To measure the electrical contact resistance between gas diffusion layer and bipolar graphite plate, and compare the measured value with theoretical contact resistance model

- ❖ Contact Resistance Measurement
- ❖ Contact Resistance Model



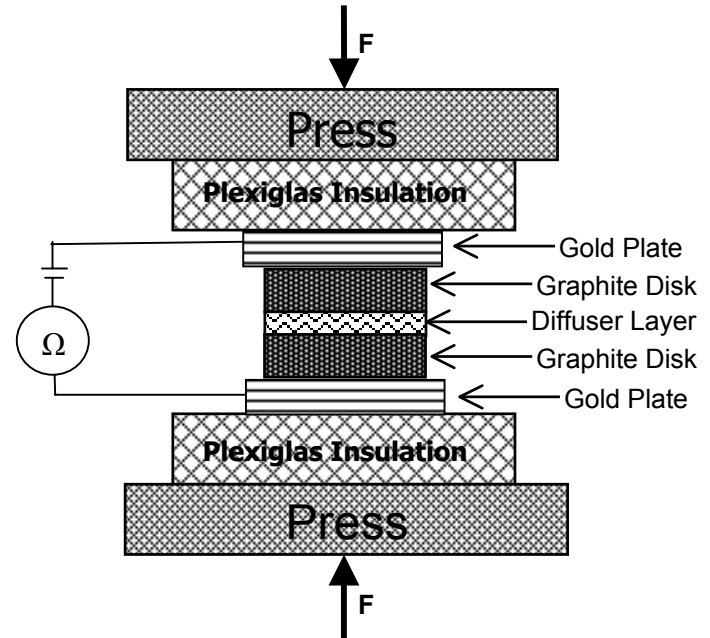
Contact Resistance



- ❑ The contact resistance at the interfaces of fuel cell components impact operational voltage loss and heat management.
- ❑ Goal: to measure contact resistance between GDL and bipolar plate material, as function of the clamping pressure and GDL material.



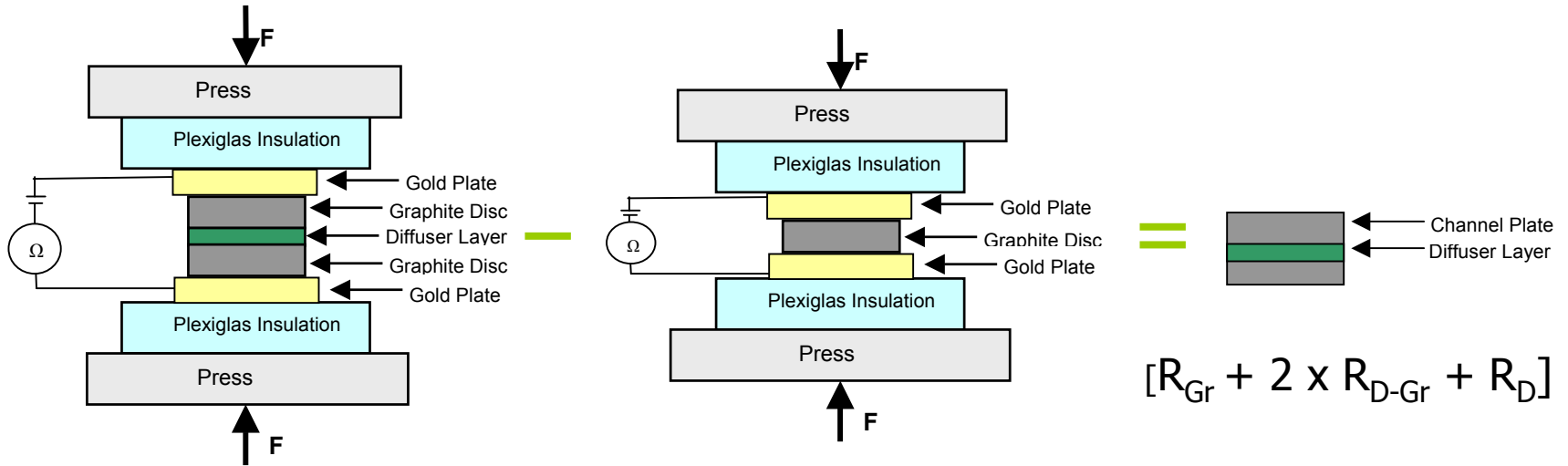
Experimental Setup



- ❑ Setup consists of a sandwich of gas diffusion layer placed between two graphite disks, held between two gold plates; Plexiglas top and bottom layers provide electrical insulation.
- ❑ The sandwich is placed in between the platens of a Tetrahedron MTP-10 press with programmable pressure control.
- ❑ Quadtech 1880 milliohmmeter used to measure electrical resistance values



Measurement



Total resistance setup,
 $[R_{tot}]$

Resistance of Gr and Gr/Au,
 $[R_{Gr} + 2 \times R_{Au-Gr}]$

$$R_{D-Gr} = 0.5 \times (R_{tot} - 2 \times R_{Gr} - 2 \times R_{Au-Gr} - R_D)$$

D - Diffuser Layer

Gr - Graphite Flow Channel Plate

Au - Gold Electrode Plate

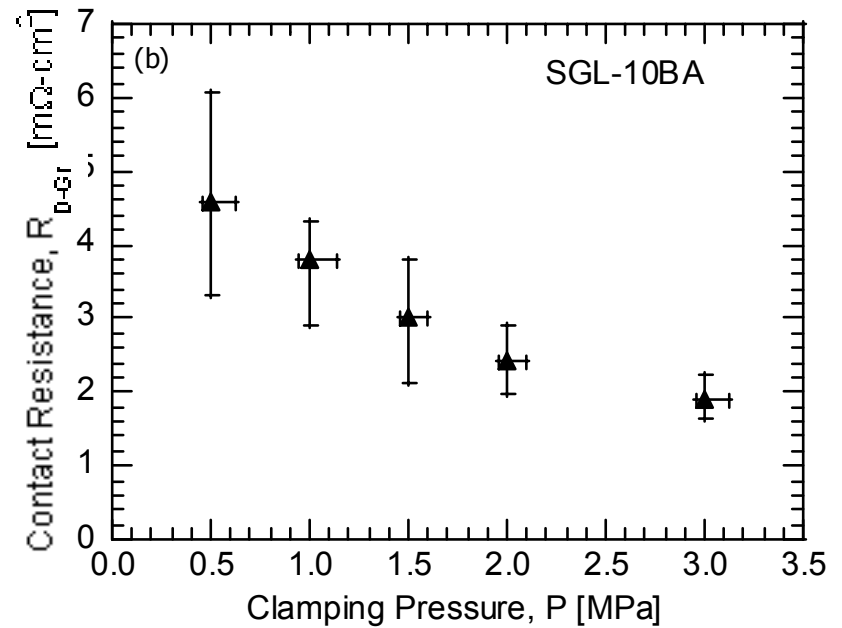
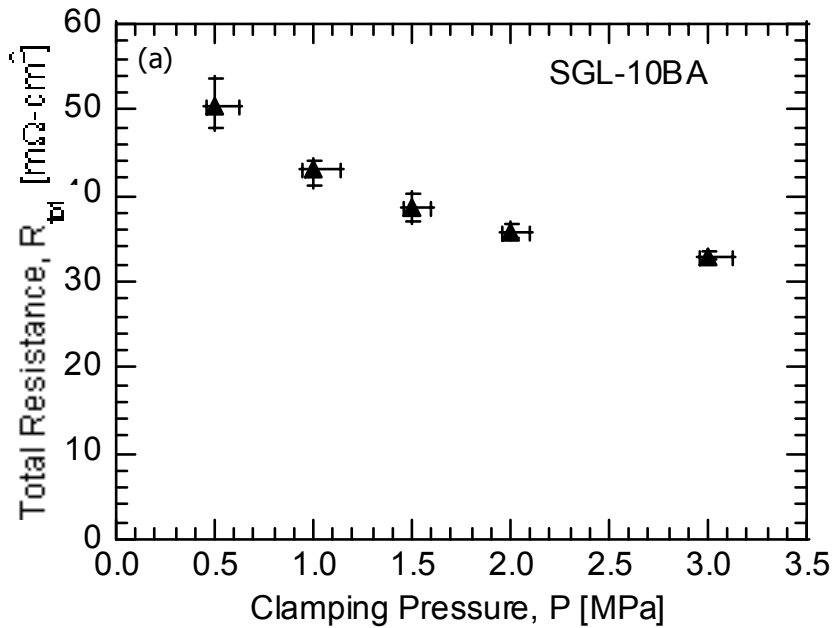
Tot- Total resistance of the setup

D- Gr – Contact Resistance between Diffuser and Graphite Plate

Au-Gr – Contact Resistance between Gold and Graphite Plate



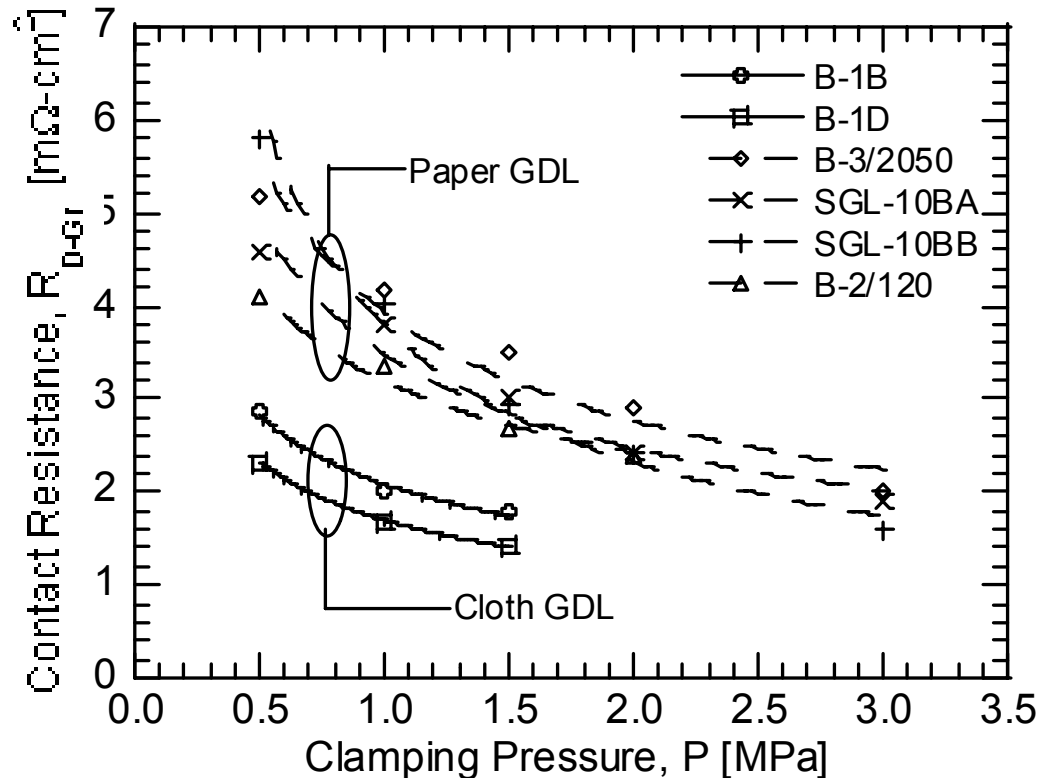
Total Resistance and Contact Resistance



- Fig. (a) shows the **total resistance** measured for the overall setup including SGL-10BA, a paper based GDL, in contact with graphite bi-polar plate.
- Fig. (b) indicates the **contact resistance** between SGL-10BA and graphite bi-polar plate interface.
- Contact resistance decreases with increase in clamping pressure due to an increase in contact area on account of asperities getting flattened.



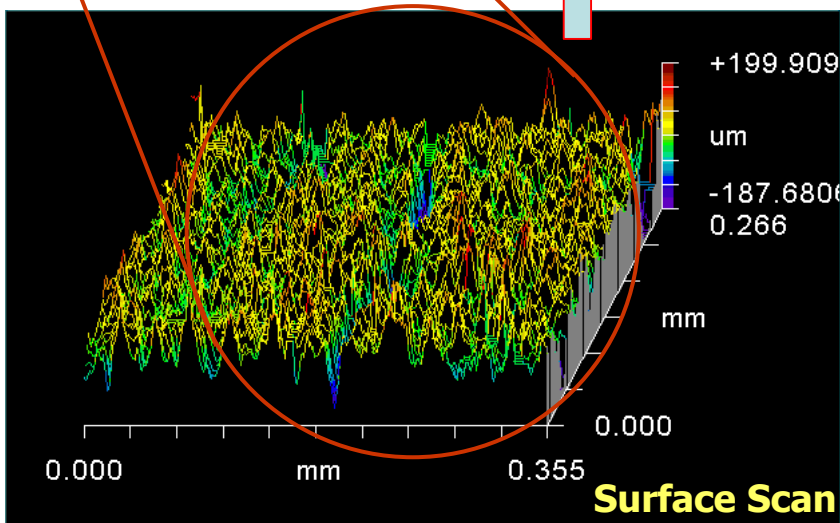
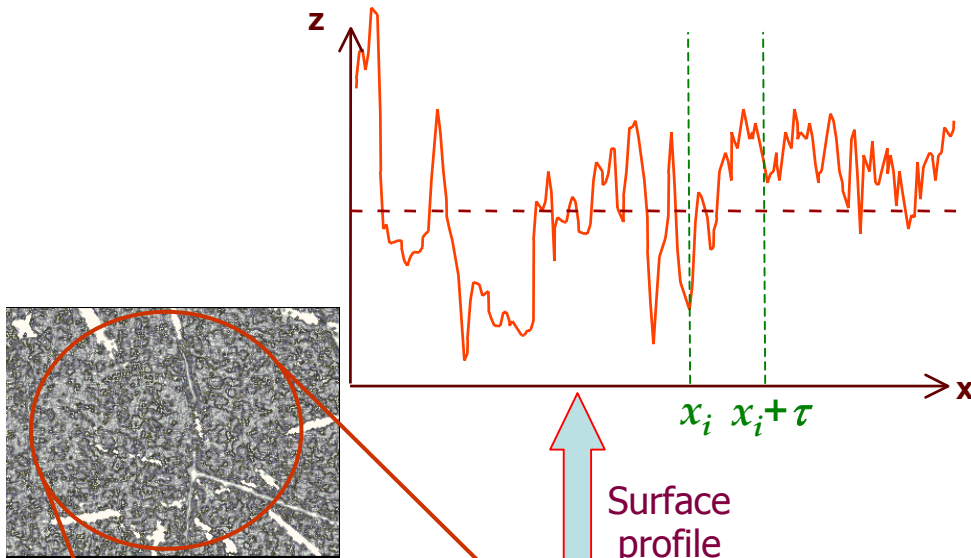
Summary of Contact Resistance Values



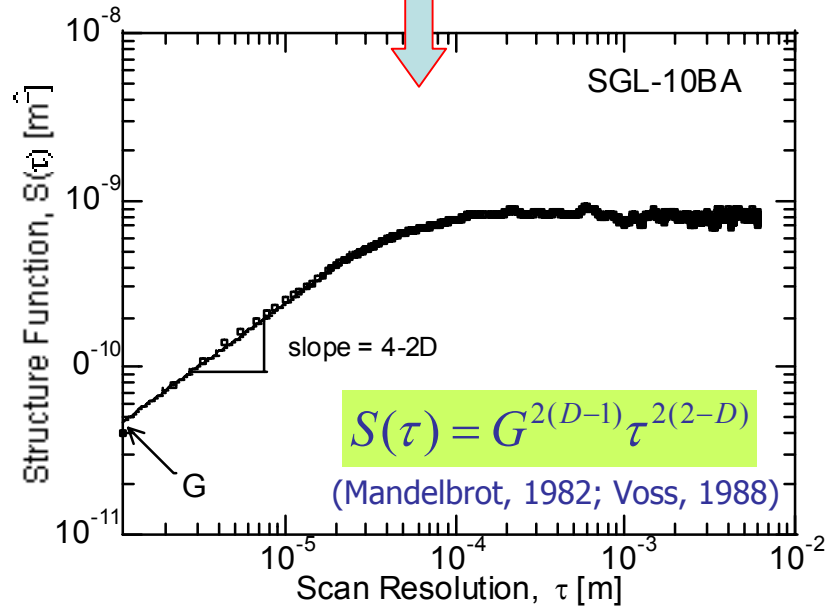
- The contact resistances of all the GDLs used for the test are summarized above.
- It is observed that the cloth based GDLs have a lower contact resistance, compared to paper based GDLs.



Contact Resistance Model



$$S(\tau) = \sum_i [z(x_i + \tau) - z(x_i)]^2$$



$$R = \frac{\Gamma(m, D, G, \lambda) C}{L^D} \left(\frac{D}{(2-D)P^*} \right)^{\frac{D}{2}}$$

(Majumdar et al., 1989)

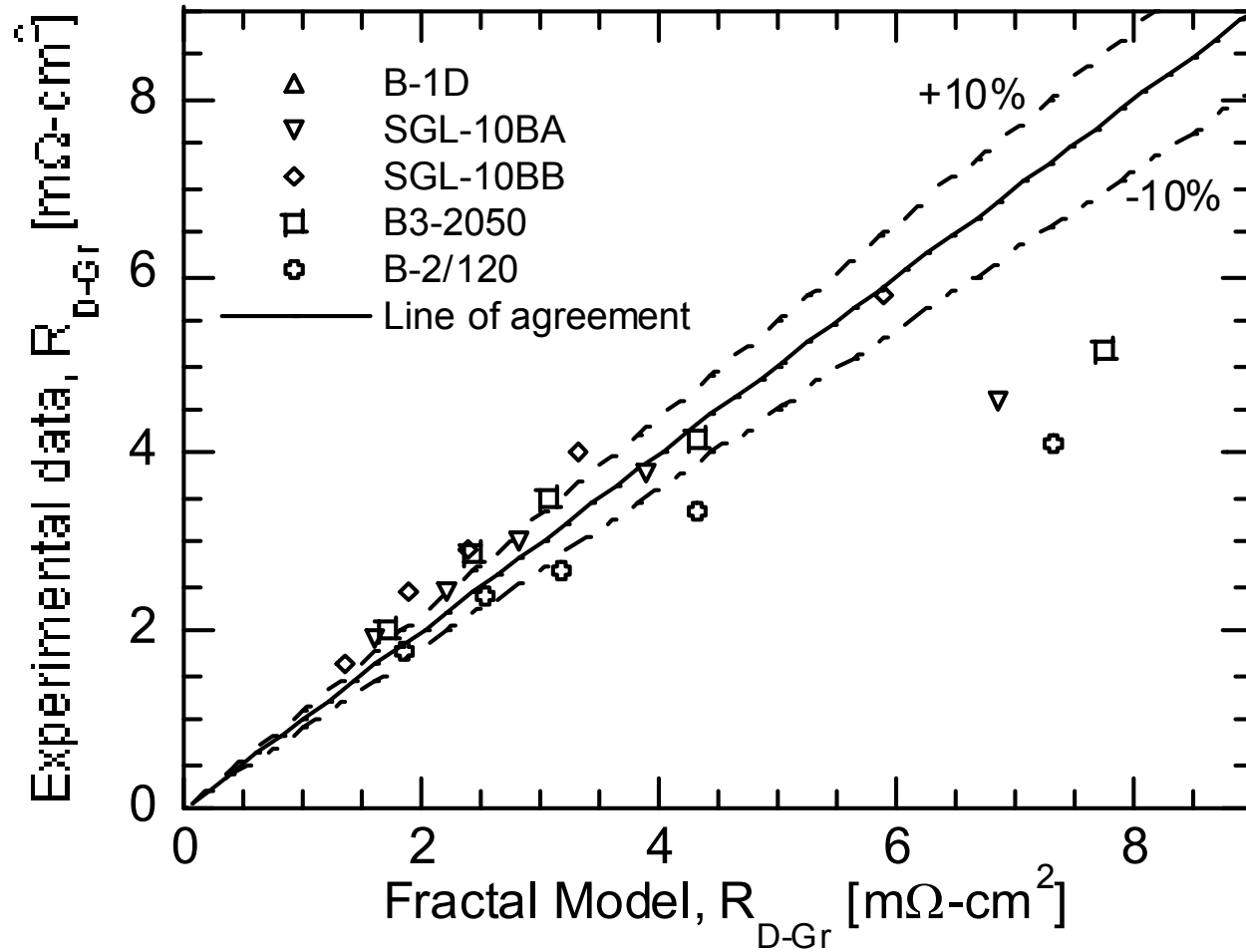


D and G Values

GDL	D	G [μm]
SGL-10BA	1.627	20.01
SGL-10BB	1.652	14.35
B-3/2050	1.685	11.74
B-2/120	1.527	17.71
B-1B	-	-
B-1D	1.698	16.63



Contact Resistance Model Validation



Summary

- ❑ Measurement and modeling of contact resistance at the electrode/flow channel interface was reported.
- ❑ Measured contact resistances are reported over a range of clamping pressure for various paper-based and cloth-based gas diffusion layers
- ❑ The contact resistance between the rigid graphite plate with a soft electrode surface was found to be dependent on the compressive modulus of the softer material

- ❑ Looking ahead...
 - ❖ Integration of the contact resistance model with a comprehensive fuel cell model to predict the overall voltage loss



