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A new generation of materials for fuel cells and the hydrogen economy

Overview

Fuel cells, in conjunction with sustainable methods of fuel production, transport, and storage, are only now emerging as a response to fossil fuel pollution. Bridging the gap between current technology and commercial implementation of fuel cells will require the development of new materials. My research attempts to bridge this gap: by developing new materials, I hope to overcome the limitations in current fuel cell research.

Problems with fuel cells

Current fuel cells suffer from numerous problems. The three largest problems are:

1) **High cost**. Too many expensive materials, from the catalyst to the membrane, are used in the production of fuel cells.

2) **Poor long-term stability**. The best fuel cells have run only 500 hours before ceasing to function.

3) **Low efficiency**. The catalysts, especially in the oxygen electrode, do not work with high efficiency.

Needed: highly functional electrodes

My research focuses on the development of new electrodes and catalysts. The figure "How fuel cells work," shows how the electrodes must:

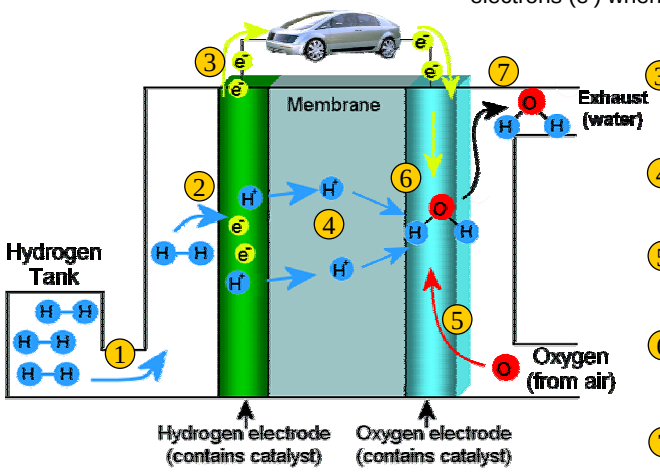
1) be porous enough to allow hydrogen, oxygen, and water to enter and leave easily

2) contain efficient catalysts that aid in the breakdown of hydrogen and the formation of water.

3) allow electrons and protons to move through the electrodes.

How fuel cells work

1. Hydrogen enters fuel cell from tank.
2. Hydrogen falls apart into protons (H^+) and electrons (e^-) when it encounters the catalyst
3. Electrons leave the fuel cell to power an electric motor in a car.
4. The protons (H^+) move across the membrane to the oxygen electrode.
5. Oxygen enters the fuel cell.
6. The protons, oxygen, and electrons react with each other to form water.
7. Water is exhausted from the vehicle.



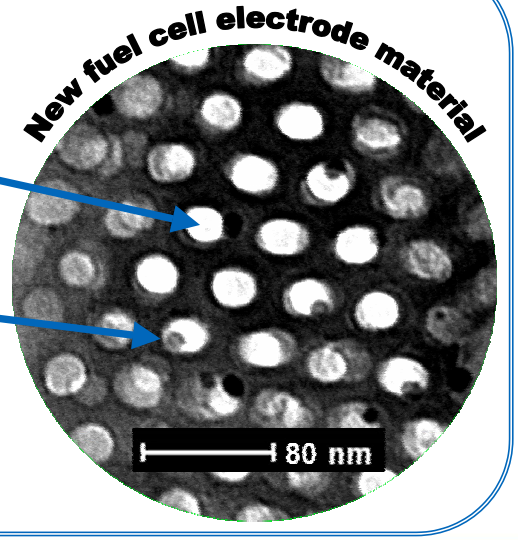
The solution

We have developed new materials, which meet a number of our criteria.

Regularly sized pores (white circles in the image) allow the transport of gasses and liquids.

Catalyst size and composition can be controlled (black circles).

We have developed new techniques which may lower the cost, improve the stability, and increase the efficiency in fuel cells.



Project website: http://abruna.chem.cornell.edu/fuelcell/home.html

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