Formic Acid Fuel Cells: New Possibilities For Portable Power

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The objective of this paper is to provide an overview of recent work that demonstrates that direct formic acid fuel cells show exceptional properties for portable power applications. Formic acid is a common organic acid. It is produced naturally by bacteria and insects, and decomposes readily in the environment with no dangerous byproducts. Formic acid is unique in that it shows very low crossover through Nafion membranes and shows near PEM performance with liquid fuels.

Figure 1 compares the performance of a direct formic acid fuel cell (D***FA***FC) to that of a PEM fuel cell and a direct methanol fuel cell (D***M***FC), measured in Fuel Cell technologies fuel cell hardware at 21 C with dry air. The performance of the D***FA***FC varies strongly with the catalyst type. With Pt/Ru, the current output of the D***FA***FC at 0.5 V is approximately double that of the D***M***FC but still not especially high. However, when we switch to a proprietary catalyst the activity is substantially enhanced. At 21 ^{o}C the D***FA***FC produces 500 mA/cm^2 at 0.5 V. The result looks very similar to that for a PEM fuel cell. Clearly, significant power is obtained

Passive Formic Acid Fuel Cells

We have built a number of passive fuel cells running on formic acid. The basic design is to suspend a standard MEA between metal current collectors and then attach the assembly to a fuel reservoir, in such a way that the cathode is open to the air and the anode is exposed to fuel. One then loads the fuel reservoir with fuel, and runs the device like a battery. There is a significant loss of performance when we switch to passive devices. Liquid water accumulates in cathode catalyst layer and gas diffusion layer, which reduces the open circuit potential At higher currents, the cell performance becomes limited by oxygen diffusion, so the maximum current is 400 mA/cm^2. Still, even without pumps, valves or controls, our best double sided cells produce 220 mA/cm^2 at 0.5 V. A double-sided cell, like those in Figure 2, with 2 in^2 of active area can produce almost 1.5 watts. Two cells are enough to power a cell phone.

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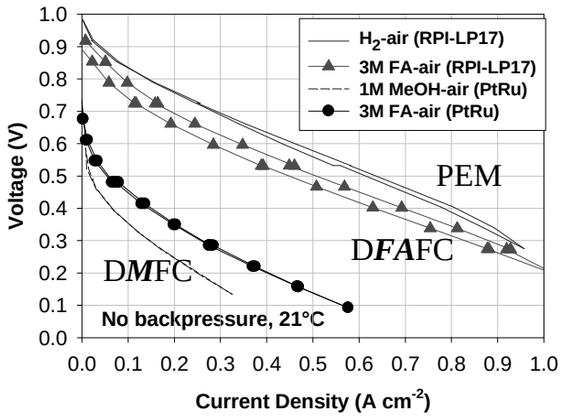

Figure 1 A comparison of the VI characteristics of D***FA***FC, D***M***FC and PEM fuel cells at 21 ^{O}C. The D***FA***FC and PEM data were taken with a patent pending[8] Renew Power catalyst on the anode, and HiSpec 1000 on the cathode. The D***M***FC measurements were done with HiSpec 6000 on the anode, and HiSpec 1000 on the cathode. Anode and cathode loadings were 8 mg/cm^2

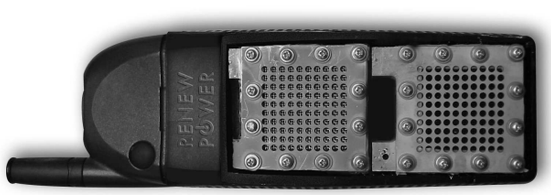

Figure 2 A photograph of two of Renew Power's fuel cells mounted in a cell phone.