Efficient fuel cells powered by enzymes

Alternative energy sources don't yet pack the desired punch – but researchers in Oxford are changing that by developing fuel cells inspired by nature.

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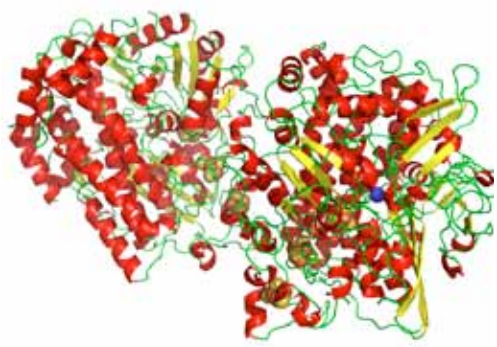
We're all aware of the desperate need for alternative energy sources, but most solutions can't compete with fossil fuel technologies because they're too inefficient. In the Armstrong Group of the chemistry department, their solution is to investigate how we can borrow from nature to make alternative energy technologies work better.

And when it comes to efficient processes, nature has a trick up its sleeve: enzymes. These proteins increase the rate of chemical reactions, and many fit the bill for alternative energy use perfectly as they speed up the inter-conversion of humble water into hydrogen and oxygen gas – the reaction that's used in modern fuel cells. Best of all, they do it with the highest rates and minimum of energy waste.

Inspired by these enzymes, the Armstrong Group are developing prototype fuel cells that use them in place of platinum – the currently used catalyst, which is expensive and inefficient – to create dramatically more efficient cells. They use enzymes called hydrogenases to speed up the production of protons from hydrogen. These protons are coupled to another reaction producing oxygen ions, in turn producing electricity and water as a by-product, creating a system that behaves just like a normal fuel cell. Because enzymes are so much more effective than platinum, these fuel cells could provide a huge leap forward in our renewable energy efficiency.

But the real excitement lies in another property of enzymes because, unlike conventional catalysts, they're extremely specific. That means that while normal fuel cells have to have complex structures to keep the two reactions separate, enzyme-based fuel cells can do without, making the cells tiny – small enough to power your mobile phone, even. Not only that, but there is no need to separate the hydrogen and oxygen, meaning that the fuel source can be a non-explosive mixture of hydrogen and air.

The group's initial work with enzyme catalysts in fuel cells won them the Carbon Trust Innovation Award in 2003. Since then, a string of patents suggests that taking inspiration from nature really might help our energy crisis.



'Fraser Armstrong recognized early on that enzymes catalyze reactions at the heart of energy conversion processes important to technology. Progress in the Armstrong group has established them as leaders in this important step towards efficient energy conversion to meet human needs.'

Tom Moore, Professor of Biochemistry, Arizona State University

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